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PRELIMINARY ECOLOGICAL SURVEY

OF THE

ISLAND OF HAWAII

BY

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AND

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INTRODUCTION.

The island of Hawaii is the most southeastern island of the Hawaiian chain, located in the Pacific Ocean some 2040 miles west of North America and 1860 miles from the Marquesas, the nearest high island neighbours. The main mass of the island lies between 19 and 20 degrees north latitude and 155 and 156 degrees west longitude. Within its area of 4030 square miles, lie 5 mountain

(1) In September 1937, I had the privilege of making a short trip to the Hawaii Islands, as C. R. B. special advanced Fellow. With the aid of Mr. S. H. Lamb, Assistant Park Naturalist, a preliminary survey of the vegetation of the Island of Hawaii could be started. The joint study was continued some time by Mr. Lamb, whose kind cooperation and unselfish work are most deeply appreciated.

W. ROBYNS.

masses, Mauna Kea, 13,784 feet, Mauna Loa, 13,680 feet, Hualalai, 8,251 feet, Kohala, 5,505 feet and Kilauea, 4,090 feet above sea level. The large size and the great variation in altitude, combined with the other site factors, produce a wide variety of environment with a complex vegetation. It is with this complex vegetation that this paper deals.

SCOPE.

The student of plant life of the Hawaiian Islands finds a large amount of material on taxonomy, but the field of ecology and plant sociology is scarcely touched. It is the purpose of the writers to present a preliminary study of the vegetation of the island of Hawaii and the role of plant succession in the floral picture. The problem will be to present a classification of the natural plant formations, and then show the successional changes that take place on the new lava flows and on areas wholly or partially devegetated from other causes.

IMPORTANCE.

Several agencies on the island of Hawaii are vitally interested in the question of plant succession on the areas under their respective control. An important aim in the national park is to maintain the vegetative cover in its natural state. The first essential is to recognize that condition, and to allow for the natural changes brought about by succession.

It is the policy of the Territorial forestry service to maintain on the forest reserves the most efficient water conserving vegetative cover. If the desired end is a complex, many storied forest, it becomes vitally important to know by what steps in plant succession that condition can most readily be realized. It may prove impractical or impossible to maintain a high forest of many stories on the areas naturally covered by a formation of low plants or shrubs. On the other hand it may be unnecessary to plant trees on certain areas, as they will naturally appear at a later stage in succession. In that case the only reason for planting trees is the desire to hasten the development of this later stage.

The matter of plant succession is also of importance to the agriculturist. The ranchers of Hawaii are greatly troubled by the inva-

sion of *Psidium Guajava,* Guava, and *Lantana Camara* on pasture land. When the full story of plant succession for these areas is known, it may be possible to point to natural means of control through proper cultural methods, particularly if the matter is given the status of a long time problem.

In summation of the importance of the whole problem of plant succession in relation to plant economics, it is sufficient to say that nature will do much to heal her scars if let alone, but may do the job much faster if given intelligent cooperation.

HISTORICAL.

Up to the present time, the chief point of attack of the problem of Hawaiian plant life has been taxonomic classification. Hillebrand's work (1888 a) was the first complete flora and remains the only single work covering the whole field. Since that time, several families and genera have been monographed. At the present time, Degener (1932) is bringing all of the work together in a Flora Hawaiiensis.

Hillebrand (1888 a and b) made the first attempt to classify the vegetative life zones, recognizing five zones based largely on elevation.

Hillebrand's classification briefed :

1. Lowland zone. — Includes the open country, grass covered after rains, with isolated trees or clumps of trees. He included the littoral species in this zone.
2. The lower forest zone. — Includes the west tropical forest up to between 1,000 and 2,000 feet, characterized by *Aleurites moluccana,* Kukui. On the lee of Haleakala (Maui) and Mauna Loa, this zone rises to 2,500 feet and the vegetation is dwarfed: « There are no trees properly speaking, everything is low shrub, stunted and gnarled, with stiff branches ». (Hillebrand, 1888 a, p. XXV).
3. The middle forest zone. — The region lying in the clouds, in which is developed the greatest luxuriance in trees and jungle. This is the region typically inhabited by *Metrosideros collina,* Ohia Lehua, *Acacia Koa,* and the tree ferns, but under the lee of the high mountains of Hawaii, part of

this zone is low shrub. Its upper limit lies around 5,000 to 6,000 feet.

4. The upper forest zone. — This zone stretches on up to 6,000 or 9,000 feet, but extends to 11,000 feet on Mauna Kea. It is characterized by stunted trees, chiefly *Sophora chrysophylla* and *Myoporum sandwicense* with « between them luxuriate shrubby *Compositae, Raillardiae, Dubantia, Campylotheca,* and *Artemisia,* Strawberries, Brambles, and the Ohelo, *Vaccinium* ». (Hillebrand, 1888 a, p. XXIV).
5. Bog zone. — A zone found on the table like tops of the mountains on Kauai and Maui. Rock (1913, pp. 75 and 76) also mentions bogs on the Kohala mountains of Hawaii and one on Molokai; Hosaka (1937) has found a bog on Oahu.

Rock (1913) enlarged upon this classification, adding a strand zone, which Hillebrand included in his lowland zone, and subdividing each zone into a wet and dry section. He devoted a chapter to the detailed floristic description of the forest regions of Hawaii, without attempting to apply his zone classification except in a very general way.

These are classifications of the zones of vegetation based mainly on floristics, without particular attention to the broader developmental basis. In order to study, classify, and determine the climax formations, it is necessary to understand the successive developmental stages that the plant community goes through to produce each climax formation.

The work of MacCaughey(1917), Campbell(1920), Forbes(1912), and just recently Hosaka (1937), mark te beginning of detailed ecological work. Unfortunately Forbes died just as he was making a beginning on the problem of plant succession on lava flows. Hosaka's work is a very intensive ecological and floristic study of one typical gulch on Oahu. Dr. H. L. Lyon (unpublished) has carried on some work concerning plant succession on lava flows.

As no ecological work can be accomplished without detailed records of rainfall, humidity, cloudiness, soil moisture and temperature, wind velocity, air temperature, and other site factors, we will deal, in the first place, with the environmental factors of the island, using the actual available data.

ENVIRONMENTAL FACTORS.

In Hawaii the most variable factor is climate, the edaphic (soil) factors remaining fairly constant over the whole island. Climatic factors are generally constant over large areas of a continental land mass. Here, owing to the very rugged topography and the high mountains, extreme changes occur within a few miles. The greatest variable is rainfall.

Rainfall.

Except for the coastal region, the rainfall data for the island are very incomplete. However, enough records have been kept in the interior to show some striking examples of variations in a short distance. At Puu Oo, elevation 6,450 feet, the mean annual rainfall is 101 inches, while Humuula, elevation 6,685 feet and 5 1/2 miles distant, receives only 32 inches per year. At Glenwood, elevation 2,300 feet, the mean is 227 inches; at the Volcano Observatory, elevation 3,984 feet, and 10 miles distant, the mean is 98 inches, while at Pahala, 20 miles distant from the Volcano Observatory, and at an elevation of 850 feet, the average is 42 inches per year. These figures show the great variation in rainfall as one passes from the wet side to the dry side of the island. The variations are as great as one climbs up the slope on the wet side. For example at Hakalau, elevation 200 feet, the mean is 142 inches, while about 1 1/2 miles above that station, at an elevation of 1,200 feet, the rainfall averages 273 inches. The map of the rainfall (Fig. 10) shows quite clearly the distribution. Graphs (Fig. 11) show the seasonal distribution to be quite uniform.

Over large areas on the windward side, a heavy rainfall, spread over the entire year, makes moisture conditions ideal for continuous plant growth, especially in the huge valleys cut by the precipitous waters into the rocky wall of the western end of the island. In the dry regions of the leeward side, the moisture that does fall usually occurs as torrential rains at infrequent intervals. This produces a desert condition suitable for a very limited number of plant species. The result is sharply marked boundaries between areas of abundant and sparse growth.

Atmospheric Temperature.

An isothermal map of the island (Fig. 10) shows considerable variation in temperature for different areas, but a graph (Fig. 12) shows the temperature of a specific place to be constant within a very narrow range throughout the year. There are not sufficient temperature records of inland regions to draw a map showing mean maximums and minimums.

The latest available summary of climatological data for Hawaii was published in 1918. Daingerfield (1918) states that it is doubtful if frost ever occurs below the 2,500 feet level. At Glenwood Experiment Station, elevation of 2,300 feet, a temperature of 38° F. was recorded without frost. The Hawaiian Volcano Observatory has occasionally reported frost at 3,894 feet.

The lowest temperature in 6 years at the Volcano Observatory was 40° F. The minimum at Waimea, elevation 2,700 feet, in 11 years was 34° F. and the lowest at Humuula, 6,685 feet elevation, in 7 years was 25° F.

The lowest mean daily minimum temperature reported was at Humuula with 42° F., while most sea level stations reported about 65° F. If records were available for the higher regions, they would be much lower than the Humuula record.

Two points on the island reported a maximum temperature greater than 93° F.: Mahukona, 98° at 11 feet elevation and Pahala, 96° at 850 feet. The highest mean daily maximum temperature was at Mahukona with 87.1° F., while most of the near sea level stations reported between 78° and 80° F.

From the temperature studies that have been made, it is assumed that temperature drops 1 degree F. for each 320 feet of ascent. This produces concentric temperature zones around the island. The lowest zone, up to 2,500 feet, is definitely tropical, with never any frost and uniform within a narrow range throughout the year. Frost is likely to occur at infrequent intervals in a zone between 2,500 feet and a short distance above 4,000 feet, but ice never forms. The upper limit is not known. There is a zone above the 4,000 feet level, extending to between 6,000 and 7,000 feet, where ice may form but not much thicker than a window pane. Here snow seldom or never falls.

The upper limit of the third zone is not definitely known, but above it, up to about 10,000 feet, snow may occur occasionally and

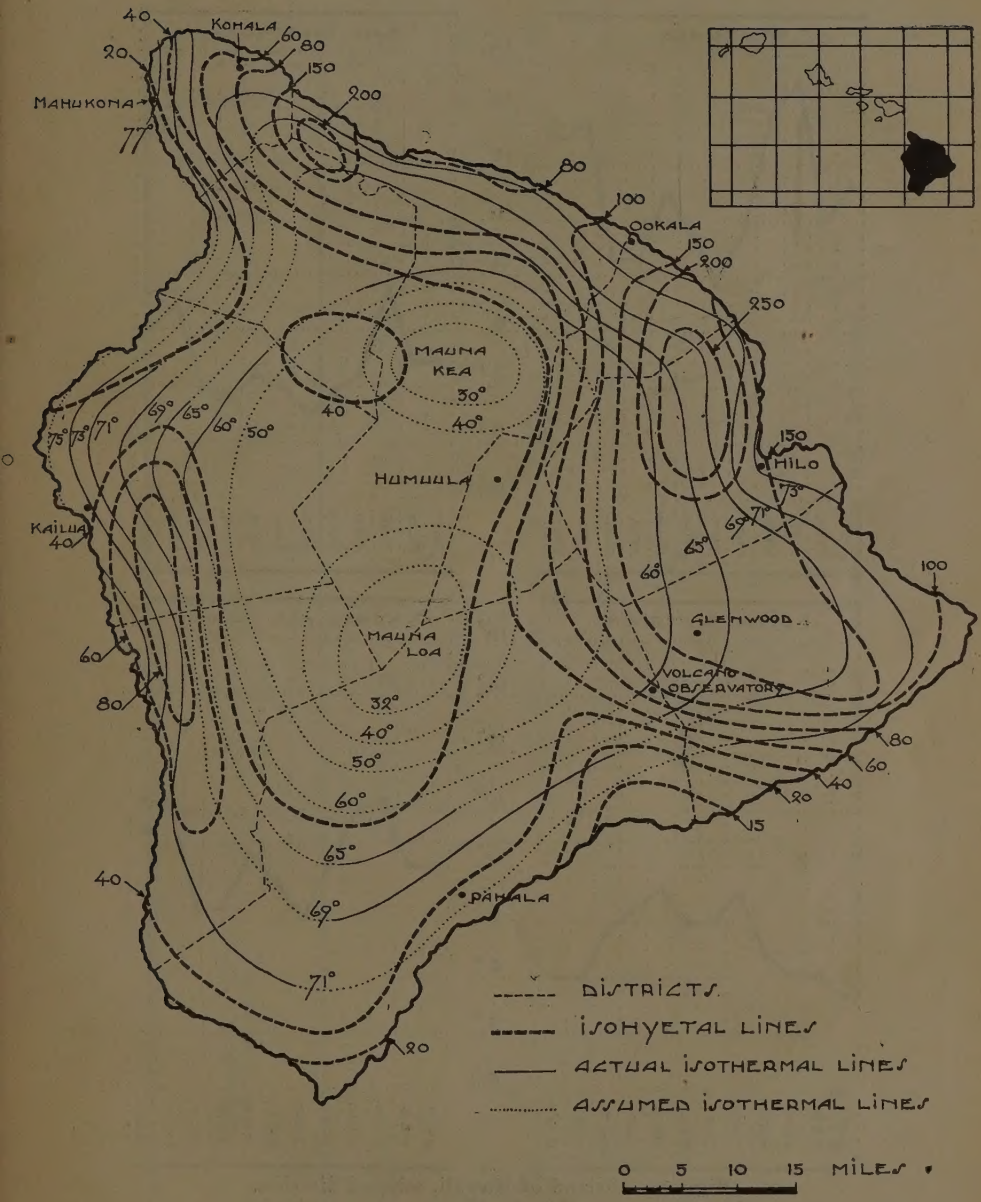


Fig. 10. — Island of Hawaii. Temperature and rainfall map, based on Weather Bureau maps.

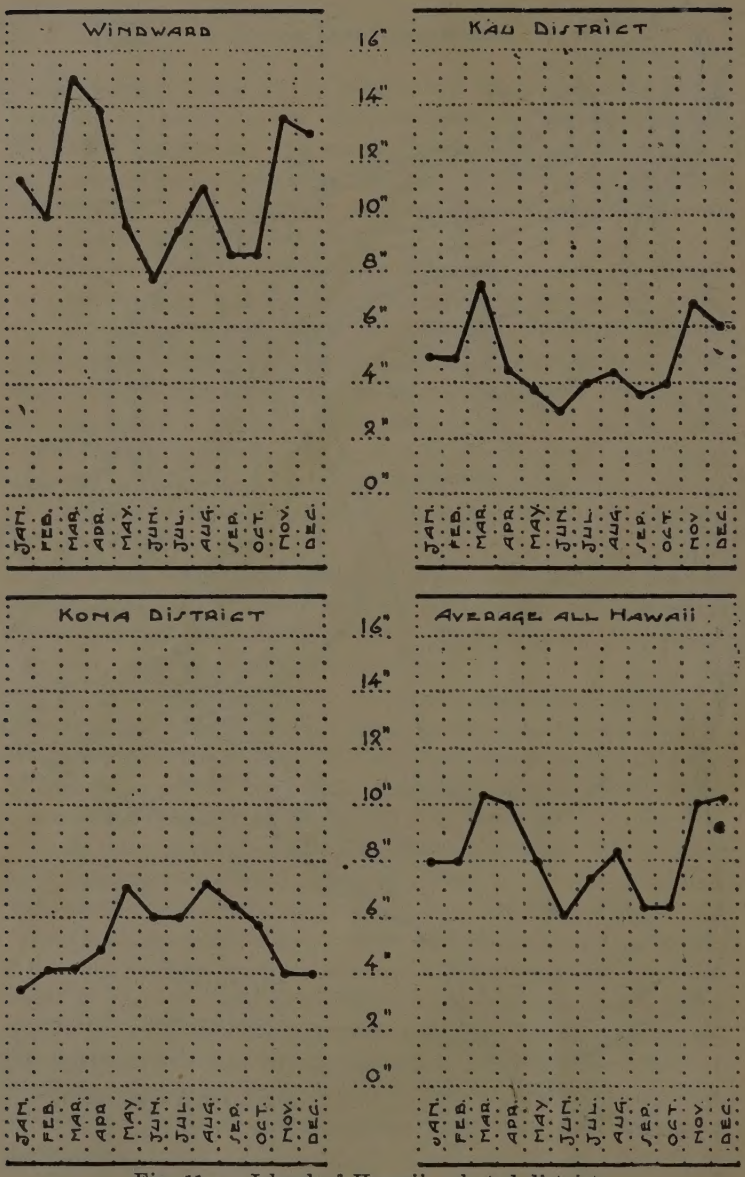


Fig. 11. — Island of Hawaii, selected districts.
Comparative monthly distribution of precipitation.

Station and Elevation above sea level	Years of record	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Mahukona 11'	6	75.5	74.3	75.9	75.7	77.9	78.9	80.0	80.4	79.8	78.6	78.3	75.6	77.6
Hilo 40'.	14	69.7	69.2	69.8	70.6	72.2	73.0	73.9	74.8	74.4	74.0	72.6	70.8	72.1
Pahala 850'	14	68.4	68,4	68.3	69.8	70.8	71.8	73.2	73.7	73.8	73.1	71.6	70.1	71.1
Waimea 2700'	11	61.1	60,6	61.2	61,8	63.1	63.2	64.0	64.9	65.3	64.9	63.3	61.2	62,9
Volcano Obs. 3984'	6	57.3	57.9	58.2	59.2	61.3	61.6	62.6	63.5	63.1	62.6	60.5	59.1	60.6
Humuula 6685'	7	49.8	50.3	48.8	49.0	51.6	52.9	54.6	55.5	54.5	54.4	52.0	51.3	52.0

Fig. 12. — Island of Hawaii. Selected stations. Mean temperatures.

probably freezing temperatures occur very often, although it is not too cold for some plant growth. Above 10,000 feet, snow falls frequently and ice forms regularly. Snow and ice may be found in sheltered places almost the year around, especially above 12,000 feet. There is no definite warm season suitable for abundant plant growth.

Sunshine.

Sunshine is abundant in some areas while in others it is cloudy part of almost every day. The most sunny exposures are on the lee side of the island below 2,000 feet. The less sunny exposures occur on the windward side. The belt between 2,000 and 6,000 feet is cloudy a large percent of the time. Two stations, Glenwood at 2,300 feet, and the Volcano Observatory at 3,984 feet, report more than 300 days a year with 0.01 inch or more of rain per day. They report about 100 days clear, more than 100 cloudy, and about 160 part cloudy.

Some stations in the sunny areas report as low as 23 days with rainfall 0.01 inch or more, with as many as 232 clear days per year. The areas that have the largest percent of cloudy weather, have, generally speaking, the greatest precipitation and are most favorable to the production of a dense cover of vegetation.

Soil Origin.

The basic origin of all the soil of the island of Hawaii is volcanic. The volcanic products are all basaltic. The material may be volcanic ash, scoria or flow rock (Powers, 1932). The physical character of the soil depends upon the relative amounts of those three materials and the degrees of weathering that has taken place. The older soils at the lower elevations are red and approach the type known as laterite. Weathering has not yet proceeded far enough to produce true laterite, at least on this island. From this extreme, the soil varies through differing degrees of composition and weathering to the very recent flow rock, upon which there is almost no soil. The 1935 lava flow produced the most recent area covered by flow rock, which is located in the saddle between Mauna Loa and Mauna Kea.

Because of this great uniformity of origin, soil is not a factor in determining major zones of vegetation. Many of the same species

of plants are found growing on the newest lava as well as on the oldest adjacent soil.

Weathering.

The flow rock or lava is of two different types, the rough, clinkery material called *aa* (Fig. 34) and the smooth, more compact material called *pahochoe* (Fig. 35). The surface of an *aa* flow is composed of rubble of all sizes, exposing a great amount of surface to weathering. Plants are soon able to gain footholds in each tiny crack. The *pahoehoe* surface, on the other hand, is so solid that plants are able to find footholds only in the major cracks between the large slabs. Weathering proceeds much faster on *aa* than on the *pahoehoe*.

This difference in rate of weathering brings about very marked minor zonation of the plant life. The distribution of lava flows on the slopes of the mountains, can be traced back for a long period of time by the variation in vegetation on the different types of lava.

Soil Fertility.

The soil of the decomposed lava is relatively fertile, although generous use of commercial fertilizers is required to sustain intensive agriculture. The native soil will support a heavy growth of native vegetation. The lava itself contains the necessary elements for plant growth.

Water Holding Capacity.

Over most of the area the soil is very low in water holding capacity. There are no flowing streams on large areas of the island. Even in many places having over 100 inches of rainfall, spread throughout the year, there are no surface rivers. There are short streams on the windward side of the older part of the island, on the slopes of Mauna Kea and Kohala, where the rainfall exceeds 150 inches per year. Thus only in very small areas does water stand on the surface of the soil, even immediately following heavy rains. Fairly extensive bogs are found on the older islands. On Hawaii they are small and of little consequence. Due to this great porosity of most of the soil, a site may be physiologically dry, even though moistened by 100 inches of rain per year.

Water holding capacity is greatly increased in ash bed soils, as chemical weathering changes the ash to yellow clay. The lava flows, however, show very little chemical change, remaining very porous for a long time.

Influence of Soil on Plant Succession.

The variation in age of the surface, appears to break up into small units any system of vegetative zones that is set up. Careful study will show, however, that the difference in appearance of each unit is due to the developmental stage in succession, and does not constitute a separate association or formation.

Ordinarily a given lava flow does not cover all of the ground in its path. Small islands known locally as « kipukas » are left uncovered. These « kipukas » constitute a valuable key to plant succession. The vegetation on the « kipukas » is older by at least one lava flow generation than that surrounding it. Frequently the plant life on a recent lava flow appears to belong to a shrub climax, but investigation of the « kipukas » in the vicinity will show another step in succession, likely indicating a forest climax if it is in the proper climatic zone.

Summary of Environmental Factors.

In summarizing the environmental factors, it will be seen that the controlling agents governing the *nature* of vegetative formations are climatic and not edaphic. In any given elevation zone, the amount of rainfall determines whether the final formation will be hygrophytic, mesophytic or xerophytic.

Edaphic factors govern the *developmental stage* of the formation found at any given place. The more recently a given site has been covered by a lava flow, the more juvenile will be the developmental stage found. Thus, for the island of Hawaii, climate governs the *final formation,* while the age of the soil governs the *developmental stage.*

CLIMAX FORMATIONS.

Following the general classification of climax formations set up by Clements (1916), and Weaver and Clements (1929), the actual

climax formations on the island of Hawaii can be grouped as follows (Fig. 13) :

Forest Formations :

Coastal-Lowland Forest	Hygrophytic Forest.
Transition Forest	Xerophytic Forest.
Moutain Forest	Mesophytic Forest.

Parkland Formations :

Plateau Parkland	Xerophytic Parkland.
Mountain Parkland	Xerophytic Parkland.

Shrub Formations :

Coastal - Lowland Shrub	Xerophytic Shrub.
Subalpine Shrub	Xerophytic Shrub.

Moss - Lichen Formation :

Alpine Moss - Lichen	Xerophytic.

Bog Formation :

Mountain Bog	Hygrophytic Bog.

If one considers that no vegetative formation can be called climax as long as the edaphic factors are in an active state of evolution, then none of the formations are climax. On the other hand, it is believed that the formations listed do represent climatic climax types in the true sense. In so far as possible, the climax formations here described are those of the virgin state of the vegetation. Since the discovery of the island by Captain Cook in 1778, great changes, due to human activity, have taken place over a large percent of the island. For this reason, it is not possible to draw accurately the boundaries of the original climax types.

The vegetation on large parts of the island is now being held in subclimax condition, due to heavy grazing and repeated lava flows. Thus it becomes necessary to try to reconstruct the original picture as a basis for studying the present subclimax types. No attempt has been made to list all of the associations under each formation, but representative ones have been listed.

Forest Formations.

Coastal - Lowland Forest.

The coastal-lowland forest, the mountain forest and the mountain bog constitute the three most hygrophytic vegetative forma-

tions on the island. The coastal-lowland forest is truly rain forest, rainfall is so heavy and the relative humidity is so high that the site is constantly wet. This formation originally covered large sections of the coast and lowland regions on the wet side of the island, where rainfall varies from 100 to 250 or more inches, distributed evenly over the whole year. As the area best adapted to sugar cane production on this island falls in this zone, much of the native vegetation has been destroyed. (See Campbell, 1920, p. 264 and 265.)

The most prominent associations are the coastal association, *Pandanus-Cocos*, and the lowland association, *Aleurites-Pandanus*. A great variety of ferns, mosses and smaller plants are found here, many being epiphytic on the trees. There are a few lianas, the most outstanding being the Ieie vine, *Freycinetia arborea*.

At the present time, there are very few good examples of either association to be found. Over much of the territory not covered with sugar cane, dense stands of *Psidium Guajava*, Guava, and *Leucaena glauca* are now established. Small stands of *Aleuritis moluccana* are found in the gulches along the Hamakua coast and in Kona (Fig. 14).

Transition Forest.

This is a xerophytic evergreen forest, found along the dry side of the island, above the coastal-lowland shrub formation and below the mountain forest. From a broad zone below Kilauea, it extends around the island as a narrow strip through Kau and Kona, thence to South Koala, where it again forms a broad zone between Puu Waawaa and Waimea.

The climate of the transition forest is very dry, with only 20 to 40 inches of rainfall per year, mostly coming as several torrential rains during the late fall and winter months. The soil is too porous to hold this moisture, resulting in almost desert conditions, only little more favorable than found in the coastal-lowland shrub zone.

The whole area has been grazed by imported domestic and feral stock for upwards of 140 years, much of the time by a very heavy concentration of feral goats. This condition frequently makes it impossible to tell what the original condition was, but early accounts tell of heavier forest over much of the area than exists now (Zschokke, 1930).

Small samples of the best development of this forest can be seen in Kipuka Puaulu at Kilauea, Kapua in South Kona and Puu

Fig. 13. — Island of Hawaii. The plant formations; relative boundaries.

Waawaa in North Kona. This is the most complex and most diversified of all the forests on Hawaii, as Rock (1913, p. 15) has already pointed out. It is hard to definitely assign associations as no species can really be called dominant.

In Kipuka Puaulu (Fig. 15 and 16), the forest is a mixture of mesophytic and xerophytic elements; species of *Straussia, Suttonia, Sapindus, Pelea, Sophora, Osmanthus* and *Metrosideros* are most prominent. The typical developmental associes is *Metrosideros-Styphelia-Dodonaea*. The surrounding forest has been overgrazed so long it is impossible to give a satisfactory picture of the original composition. The same overgrazed condition holds true in Kona.

In Kapua (Fig. 17 and 18), the typical association is as complex as it is in Kipuka Puaulu. Rock (1913, p. 39) gives a good description of the species found. He mentions *Antidesma pulvinatum* and *A. platyphylum* as being very characteristic, intermingled with *Nototrichium sandwicense, Maba sandwicensis (Diospyros sandwisensis), Osmanthus sandwicensis, Charpentiera obovata* and *Pisonia sandwicensis (Rockia sandwicensis)*. Many other species are common. Here again the typical developmental associes is *Metrosideros-Styphelia-Dodonaea*. It is a very good region in which to study the earlier developmental stages, as many recent dated lava flows cross the zone.

At Puu Waa Waa (Fig. 20) the association is very xerophytic and still more complex than at either of the two previously mentioned places. Rock (1913, p. 49) discusses the floristics of this interesting forest quite fully. Species of *Antidesma, Dracaena, Maba (Diospyros), Mezoneurum, Colubrina, Pelea, Xanthoxylum* and *Pittosporum* are among the most common.

It will be noted that most of the same genera are represented in each of the three areas. In the intervening strips the composition is less complex, often represented by a developmental associes due to recent lava flows. Some of the species found in the climax type are scattered throughout the zone, where the soil is old enough for them to have become established. Kipuka Ki, located above Kipuka Puaulu in the Kilauea region, is an example with its clumps of *Sapindus Saponaria* (Fig. 19).

Mountain Forest.

The mountain rain forest is the mesophytic climax that covers large sections of the island, where the rainfall is near 100 inches

Fig. 14 (above). — Climax forest of *Aleurites moluccana*, typical of the coastal-lowland forest, growing in a ravine near Ookala, Hawaii. Photographed by W. Robyns.

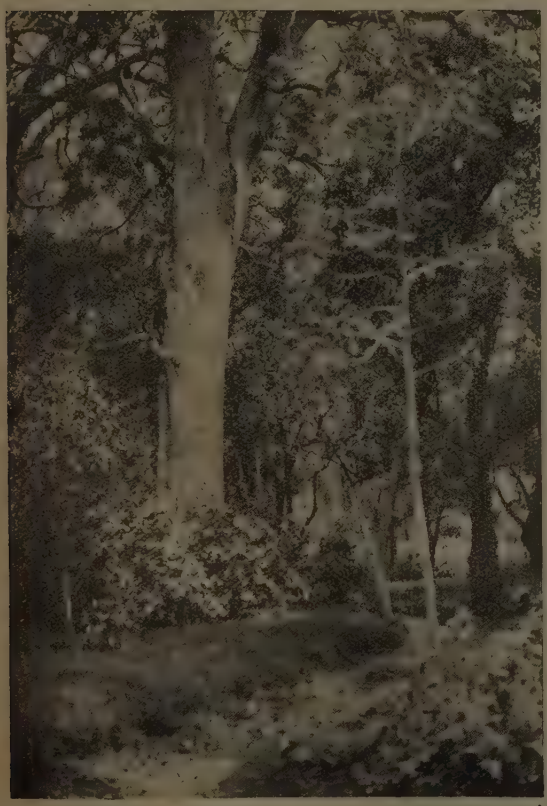


Fig. 15 (left). — Transition forest in Kipuka Puaulu, Hawaii National Park. The large specimen is *Acacia Koa*, surrounded by seedlings of *Straussia Hillebrandii*. Elevation 4000 feet. Photographed by W. Robyns.

Fig. 16 (above). — Transition forest in Kipuka Puaulu, Hawaii National Park. Reproduction of *Straussia Hillebrandii* in foreground with *Sapindus Saponaria* and *Metrosideros collina* var. *polymorpha* in background and on either side. Photographed by S. H. Lamb.

Fig. 17 (left). — Transition forest in Kapua-Manuka Forest Reserve, along the belt highway, between the 1907 and 1926 lava flows. *Metrosideros collina* var. *polymorpha* dominant in overstory with *Psidium Guajava* along roadside. Elevation 1,700 feet. Photographed by W. Robyns.

spread throughout the year. This region is cloudy much of the time with very high relative humidity. The extreme porosity of the soil is all that keeps large sections from becoming bogs covered with a hygrophytic association. In fact, that condition exists now on the older islands, and to a limited extent on Kohala on Hawaii (Rock, 1913, p. 75-76), in portions of this same zone.

The mountain forest is by far the most extensive formation, covering large continuous tracts between 2,000 and 5,000 feet elevation. Above Hilo, extending toward Kilauea, is a tract of 250,000 acres. Another extension of this same tract extends as a more narrow belt all along the Hamakua section to the north end of Kohala. Another belt extends around the southern end of Mauna Loa in Kau to Hualalai in Kona.

The *Metrosideros-Cibotium* association is characteristic throughout the formation. The forest is poor in tree species and extremely monotonous in character, *Metrosideros collina,* var. *polymorpha* forming almost pure stands. It is often 3 or 4 storied (Fig. 21 and 22) with *Metrosideros* and a few other tree species such as *Ilex sandwicensis, Cheirodendron Gaudichaudii, Suttonia Lessertiana,* varieties of *Gouldia axillaris* making up the upper story, and *Cibotium Menzicsii* and *C. Chamissoi,* the tree ferns, making up the second story. Smaller ferns in great profusion occur below the tree ferns, with a deep layer of mosses and low plants on the forest floor. Grasses are rare in the virgin forest.

Due to the very high atmospheric humidity in the areas where the mountain forest naturally occurs, a great variety of epiphytes are found growing in the trees and tree ferns that make up the two upper stories. In the region around Kilauea (Fig. 23), it is possible to find species of such divergent genera as *Astelia, Vaccinium, Metrosideros, Dodonaea, Straussia, Suttonia, Smilax, Cyrtandra, Carex, Elaphoglossum, Hymenophyllum* and many others growing in the trees. Most of these plants grow also on the ground where conditions are favorable. Much of the reproduction of *Metrosideros collina* var. *polymorpha* occurs epiphytically on ferns and trees.

Over considerable sections, the mountain forest has been disturbed the least of any of the forest or parkland formations. Much of it is made almost impenetrable by the twining growth of *Gleichenia emarginata,* Uluhi. The forest suffers greatly where grazing is permitted. The destruction of the ground cover allows the soil

to dry around the very shallow roots of the *Metrosideros collina* var. *polymorpha* trees causing heavy losses (Judd, 1929).

Introduced grasses, such as *Paspalum conjugatum* or Hilo Grass, invade the forest quickly when the undercover is disturbed, preventing to a large degree the reproduction of the tree species. *Meterosideros collina* var. *polymorpha* appears to be very intolerant of shade (Hall, 1916), resulting in slow reproduction of mature stands. It springs up very rapidly on burns and lava flows, the 1881 lava flow being heavily forested in the wetter regions. The tree's seed very frequently germinates high up on the trunk of tree ferns, or tree trunks, where conditions are favorable. It grows there as an epiphyte until roots finally reach the ground. The tree fern then frequently dies, leaving the tree on stilts.

The mountain forest and the mountain parkland above it are the most important formations from the standpoint of water conservation. The streams in the Hamakua district head in these zones. It is here that the most intensive watershed protection forestry is being practiced. In this district, large sections formerly covered with mountain forest have been so badly overgrazed that much of it is now grass land. Since reproduction of *Metrosideros* under this condition is slow and artificial regeneration with native species is very difficult or impossible, an attempt is being made to duplicate the favorable characteristics of the native forest with introduced trees.

Parkland Formations.

Parkland formations are distinguished from forest formations by the characteristics of the stands of trees. In the forest formation, the crowns of the trees typically form a closed canopy over large tracts. In the parkland formations, the trees grow in clusters of clumps with wide grassy areas between. On the island of Hawaii, these parkland types occur above the forest types, extending to the upper limit of tree-growth.

Plateau Parkland.

The plateau parkland formation covers the broad central plain of the island, between the mountain masses of Mauna Loa, Mauna Kea and Hualalai. The rainfall is between 20 and 40 inches per year, giving a very desert like aspect to much of the plateau. A large

Fig. 18 (above). — Transition forest in Kipuka Nene, Hawaii National Park. Overstory of *Metrosideros collina* var. *polymorpha* and understory of *Pteridium aquilinum*, *Dodonaea viscosa*, *Styphelia Tameiameia* and grasses. Elevation 3,000 feet. Photographed by S.H. Lamb.

Fig. 19 (left). — Transition forest in Kipuka Ki, Hawaii National Park. Note groups of *Sapindus Saponaria* in overstory with ferns in understory. Elevation 4,200 feet. Photographed by W. Robyns.

Fig. 20 (above). — Transition forest in Puu Waa Waa region, North Kona. *Maba sandwicensis* to left. *Santalum* sp. right and *Dracaena aurea* in center background. Elevation 2,000 feet. Photographed by S. H. Lamb.

Fig. 21 (left). — Mountain forest, Crater Rim road, Hawaii National Park. Prof. Robyns standing under a clump of *Cibotium Chamissoi* with *Sadleria cyatheoides* as an understory. *Metrosideros collina* var. *polymorpha* forms an overstory over all. Elevation 4,000 feet. Photographed by S. H. Lamb.

portion has been covered by such recent lava flows as those of 1843, 1859 and 1935. Other flows, such as the Keamoku flow, though occuring before 1790, are largely barren wastes.

Considerable areas at the eastern end of the plateau, in the vicinity of Humuula, are covered by an association of *Myoporum sandwicense* and *Sophora chrysophylla* (Fig. 24 and 25). Along the slope of Mauna Kea, an arborescent *Raillardia* about 15 feet high is common. *Chenopodium sandwicheum* grows to a height of 15-20 feet along the road to Humuula below the *Myoporum-Sophora* association. Bunch grass, *Erigeron albidus, Verbena bonariensis* and in some places *Achillea millefolium* may be found in the understory. The common association in the western end of the plateau near Hualalai is the same as at the eastern end. Other shrubs of the genera *Coprosma, Dodonaea, Exocarpus, Stenogyne, Ostcomeles*, and *Wikstroemia* are common (Rock, 1913, p. 46). *Erogrostis atropioides, E. grandis* and *E. lystophylla* are some of the grasses found near Humuula. A. S. Hitchcock (1922) also lists *Trisetum glomeratum, Agrostis sandwicensis* and *Aira nubigena* growing near timberline on Mauna Kea.

Mountain Parkland.

The mountain parkland forms a fairly distinct belt on the moist slopes of Mauna Kea, Mauna Loa and Hualalai, above the mountain forest. The rainfall is not as heavy as in the mountain forest. Although few records have been kept, it is thought to vary from 40 to 80 inches. The formation is xerophytic although not nearly as desert like as the plateau parkland. Small pure dome shaped stands of *Acacia Koa*, Koa, are interspersed with small stands of *Sophora chrysophylla*, with large grassy openings between (Fig. 26).

The more recent lava flows are generally covered with the *Metrosideros-Styphelia-Dodonaea* associes typical of the transition forest, but usually occuring in less dense stands.

This formation has been greatly changed by heavy grazing. It is very possible that an earlier writer might have called it a forest formation, but it is doubtful if *Acacia Koa* ever formed extensive closed stands in this zone. Much of the land now covered with grass was probably covered with *Dodonaea* and *Styphelia*, characteristically low shrubs that may be considered trees only at their optimum development. The formation on Mauna Loa is very definitely parkland at the present time. Concerning the early condition

of this formation, Menzies in 1794, reports that above the land of Kapapala the upper portion of the forest consisted of clumps of trees (Ch. Hitchcock, 1911, p. 73). From this report, it would appear that at least portions of the slope of Mauna Loa were covered with a parkland formation before grazing had ever effected conditions. In some cases, *Acacia Koa* may form a forest as the uppermost association in the mountain forest, just below the mountain parkland.

The Shrub Formations.

Coastal-Lowland Shrub.

The coastal-lowland shrub occurs as a belt of varying width along the dry side of the island, from near Kalapana in Puna, through Kau and Kona, to near Upolu in North Kohala. It is the most xeric region on the island, the rainfall falling below fifteen inches per year in some places. Because the soil is very porous and all of the years rain may fall in a few heavy storms, much of the land is barren waste. It takes the climax formation centuries to become fully established on lava flows in the dryer places.

The plants found here originally are largely of the broad leaved sclerophyllous type, *Maba sandwicensis (Diospyros sandwicensis)* being the most typical large shrub or small tree. Such plants as *Alphitonia excelsa,* Kauila, *Erythrina monosperma,* Wiliwili, *Sida fallax,* and *Waltheria indica* var. *americana*, were also common (Fig. 27). Today large tracts have been taken over by introduced species, such as *Prosopis juliflora,* Algaroba, *Acacia Farnesiana, Opuntia megacantha,* Cactus, *Lantana Camara, Desmodium uncinatum, Cassia mimosoides, Crotalaria saltiana, Leucaena glauca,* and many others. *Prosopis juliflora* grows to be a large tree and, owing to its easy adaptation to dry situations, spreads spontaneously, forming dense stands over large parts of the lower sections and changing completely the shrubby aspect to a forest aspect. *Sida fallax, Chloris inflata* and *Panicum xerophilum* are common components of the understory of the newly forming *Prosopis* association.

The typical sandy beach association is *Ipomoea-Scaevola* (Fig. 28). Scattered along the beach are many coconuts, *Cocos nucifera,* but the barren lava extends to the waterline much of the way. On the lowlands the characteristic association is *Maba-Wal-*

Fig. 22. — Mountain forest, near First Twin Crater, Hawaii National Park. *Metrosideros collina* var. *polymorpha* forms the overstory with heavy growth of *Sadleria cyatheoides* and other ferns beneath. Elevation 4,000 feet. Photographed by S. H. Lamb.

Fig. 23. — Epiphytes in mountain forest, First Twin Crater, Hawaii National Park. *Astelia veratroides* is the long slender leaved plant most conspicuous. Photographed by S. H. Lamb.

Fig. 24. — Plateau Parkland near Humuula on the great central plain. *Sophora-Myoporum* association with *Sophora chrysophylla*, *Myoporum sandwicense*, and *Chenopodium sandwicheum* in background and bunch grass and *Erigeron albidus* in foreground. Elevation 6,600 feet. Photographed by S. H. Lamb.

Fig. 25. — Plateau Parkland along road to Humuula. *Chenopodium sandwicheum* association with bunch grass in foreground. Elevation 5,500 feet. Photographed by S. H. Lamb.

theria (Diospyros-Waltheria). Grazing has continued for so long over much of this zone, that it is no longer possible to definitely delimit the areas covered, nor present a true picture of each association represented.

Subalpine Shrub.

The subalpine shrub forms belts around Mauna Loa and Mauna Kea and on the summit of Hualalai (Rock, 1913, p. 53 and Plate XIX), roughly between the 7,000 and 9,000 feet contours, although it may extend down as low as 5,000 feet in South Kona and as high as 10,000 feet on Mauna Kea. Almost nothing is known about the amount of rainfall for this zone, but it is thought to be below 40 inches. The mean temperature is probably between 40 and 50 degrees F., without much difference between summer and winter. Ice forms frequently and snow may fall occasionally but is of short duration. The zone may be very narrow in some places, especially on Mauna Kea, where Parkland species may extend to the upper limit of vegetation.

The characteristic plants are microphyllous shrubs. The typical associations are *Dodonaea-Styphelia* and *Styphelia-Coprosma* (Fig. 29), with *Geranium tridens* as a minor component associated with the *Coprosma*. On Mauna Kea species of *Raillardia* are prominent. *Dodonaea* is not as well developed here as in the mountain parkland and transition forest. Many of the same plants of typical associes of the transition forest and mountain forest and parkland are found here in the climax associations.

The subalpine shrub has been disturbed the least by grazing, with large areas on Mauna Loa probably in an essentially virgin condition. Feral goats and sheep have been a problem on Mauna Kea where more succulent plants are found.

Skottsberg (1931) lists a total of 23 species of vascular plants in the subalpine zone in the Hawaiian islands. Some of these may not be found on Hawaii. At the 7,500 feet elevation, on the south east slope of Mauna Loa, lists include the following: *Dodonaea viscosa, Styphelia Tameiameia, Coprosma montanum* and *C. ernodeoides, Raillardia* sp., *Vaccinium* sp., *Geranium tridens, Metrosideros collina* var. *polymorpha, Polypodium pellucidum, Pellaea ternifolia, Pteridium aquilinum,* and a species of *Cyperaceae.* These constitute the more conspicuous plants of the *Styphelia-Coprosma* association. Lower down, at 7,000 feet, in the *Dodonaea-Styphelia* association,

Dodonaea is much more prominent, while *Geranium* and *Coprosma montanum* are almost entirely lacking.

Moss-Lichen Formation.

Alpine Moss-Lichen.

Above all the zones of seed bearing plants occurs a zone that is frequently given very little consideration or completely ignored. It is the moss-lichen formation occuring above the subalpine shrub climax on Mauna Loa. It is alpine in character, inhabiting the region of low rainfall and frequent frost. No typical « tundra » is to be found. Snow covers the ground frequently, but seldom lasts long except at the upper limit.

Skottsberg (1931) lists two zones, the sub-alpine and the alpine. His alpine zone includes the same area as that of the present writers, the regions above timberline on the high mountains. He lists 13 species of vascular plants in this zone, all endemic. The following species are to be found at the 9,000 foot elevation on the south-east slope of Mauna Loa : *Vaccinium reticulatum* (Fig. 30) *Styphelia Tameiamcia, Pellaea ternifolia,* and a species of grass, all occuring as scattered individuals. The most abundant plant was the moss, *Rhacomitrium lanuginosum,* var. *pruinosum* (Fig. 31) found from Kilauea to the summit of Mauna Loa (Bartram, 1923). More species have been reported from this zone on Mauna Kea, due possibly to the fact that the soil is older and better developed than on Mauna Loa.

Above the Moss-Lichen formation on Mauna Loa are extensive fields of barren lava extending to the top of the mountain. The summit of Mauna Kea is covered by large barren cinder cones. It is probable that the absence of even a short warm season accounts for this barren condition. It may be quite warm in the daytime but freezes ice nearly every night. Some ice may be found in sheltered spots the year around.

Bog Formation.

Mountain Bog.

The mountain bog formation is not important on Hawaii. It is limited to the Kohala district, where the largest bog is located on the summit of Kaala, at an elevation of 5,505 feet. Other smaller

Fig. 26. — Mountain Parkland on Mauna Loa in Hawaii National Park. Clumps of *Acacia Koa* in background with *Styphelia Tameiameia* in center and *Pteridium aquilinum* and bunch grass as understory. Elevation 6,300 feet. Photographed by S. H. Lamb.

Fig. 27. — Coastal-lowland shrub above Punaluu. Clump of *Myoporum sandwicense* in center associated with *Sida fallax* and *Argemone glauca*. Elevation 400 feet. Photographed by S. H. Lamb.

Fig. 28. — Coastal-lowland shrub on the beach at Punaluu. Clumps of *Scaevola coriacea* in center, *Sida fallax* and close cropped grass in foreground. Photographed by S. H. Lamb.

Fig. 29. — Subalpine shrub, 7,500 feet elevation on Mauna Loa in Hawaii National Park. Tall *Coprosma montana* in center flanked by *Styphelia Tameiameia*, forming the *Coprosma-Styphelia* association. Photographed by S. H. Lamb.

bogs may be found in the same locality. The bogs are located in areas of extreme rainfall. Records for the upper Kohala region show as high as 503 inches for one year with a mean of 276 inches. The area is almost perpetually in fog. Due to the flat topography of these small areas, there is little run off and the water cannot seep away fast enough to keep the soil well drained. The result is an extremely wet site with a specialized plant development. Rock (1913) lists Lycopods, *Selaginella deflexa, Schizaea robusta, Raillardia scabra, Raillardia* sp., *Plantago* and *Suttonia sandwicensis* as common in the boggy area.

Summary of Climax Formations.

In this brief account of the climax formations, no attempt has been made to name all of the associations or associes. It has been the writer's intention to name only the most characteristic examples. An intensive study should be made of each formation, describing and bounding each association, and naming in so far as possible the developmental steps through which each sere progresses.

An attempt has been made to make the classification sufficiently general to cover all of the virgin types, yet specific enough so that each type can be placed in the proper formation.

In all cases care must be used to see that subclimaxes of long duration are not considered climax. If this point is kept in mind, there should be little trouble in applying the classification.

ALTITUDINAL ZONES OF VEGETATION.

In studying the zones of vegetation as set up by other writers for the Hawaiian Archipelago, it will be seen that they have been made too general for specific application to the island of Hawaii. At the same time, most of the classifications have been based on a floristic or altitudinal basis rather than on an ecological basis.

Hillebrand (1888 a and b), as already stated, gives only five zones, three of which are forest zones characterised respectively by the author (Hillebrand, 1888 b) as the *Aleurites* zone (lower forest zone), the *Metrosideros* zone (middle forest zone) and the *Edwardsia* (*Sophora*) zone (upper forest zone).

The representation of the natural formations of Hawaii, outlined

in this paper, in the life zones of Hillebrand gives following picture:

Zone 1. Lowland zone covers the coastal lowland shrub.

Zone 2. Lower forest zone parallels the coastal lowland forest.

Zone 3. Middle forest zone includes the transition forest and the mountain forest.

Zone 4. Upper forest zone includes the plateau and mountain parklands, the subalpine shrub and the alpine moss-lichen formation.

Zone 5. Bog zone includes the mountain bog.

From the phytosociological viewpoint, this classification is unsatisfactory, as not enough zones are distinguished.

In his discussion on the vegetation, Hillebrand (1888 a and b) makes no clear mention of the very important transition forest, whereas in the upper forest zone, he makes no distinction between the very different formations described by the present writers.

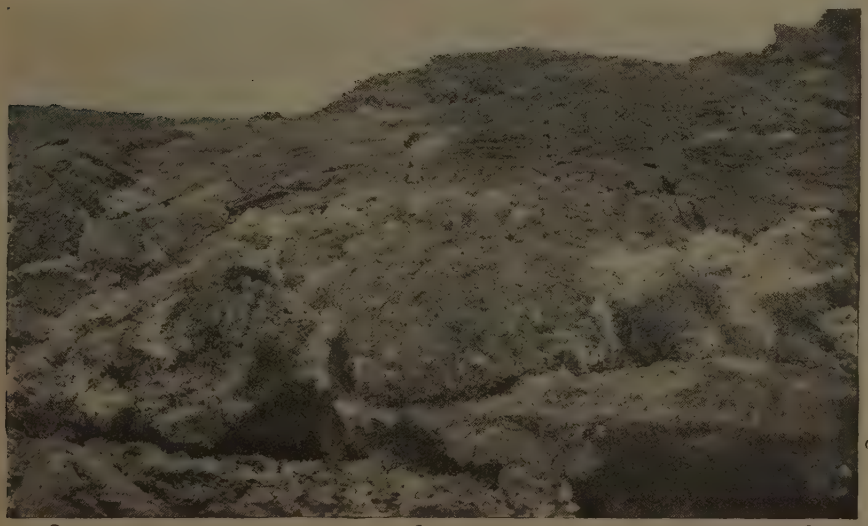
Although Rock (1913) gives a rather complete floristic discussion of the island of Hawaii, he fails to draw a very definite picture of the respective zones of vegetation as set up for the other islands. He prefers to treat the matter by giving a running account of the vegetation found in the different sections of the island. He describes however the transition forest, calling it the dry or mixed forest and including it in the lower forest zone, section b, leeward side. He compares this formation with the forests of East Java and India, which are however composed of deciduous trees.

Thus no definite attempt has been made to delimit the vegetative zones of this island even though, as Rock (1913, p. 23) says: « From a phytogeographic standpoint the island of Hawaii offers the most interesting field in the Pacific. »

Hosaka (1937) sets up a classification of the zones found in Kipapa Gulch on Oahu. He does not claim that his classification will fit the whole island, nor that it is applicable to any other island. He names six zones in the following order: Maritime, Haole Koa, Guava, Ohia, and Cloud, progressing from sea level to the top of the mountain. It will be seen that this classification cannot be used on the island of Hawaii, especially from the standpoint of native vegetation. In the first place, the chief plants of two of his zones are exotics, the Haole Koa, *Leucaena glauca*, of the Haole Koa zone and *Psidium Guajava*, Guava, of the Guava zone. He has

Fig. 30 (left). — Alpine Moss-Lichen formation at 9,000 feet on Mauna Loa, in Hawaii National Park. Notice the lone *Vaccinium reticulatum* in center. Photographed by S. H. Lamb.

Fig. 31. (below). — Alpine Moss-Lichen formation at 9,000 feet elevation on Mauna Loa, Hawaii National Park. Notice the moss, *Rhacomitrium lanuginosum* var. *pruinosum* in cracks in the lava. Photographed by S. H. Lamb.



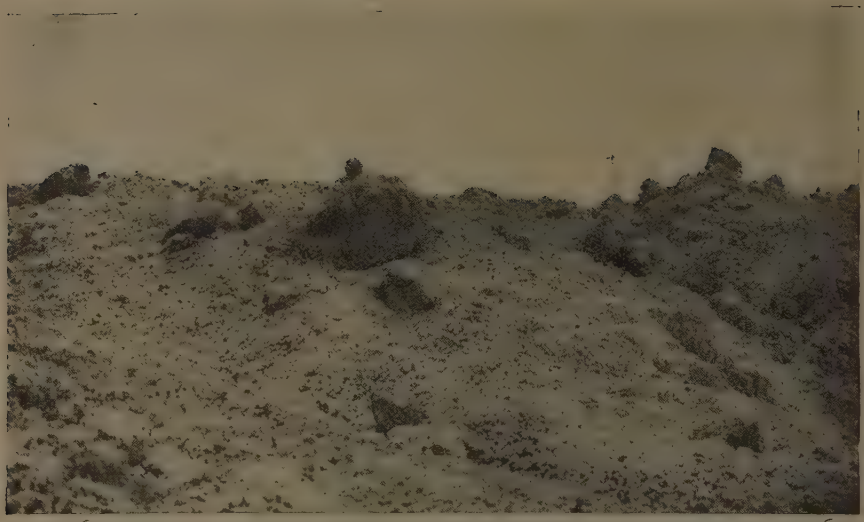


Fig. 32. — Pioneer vegetation on the 1926 lava flow in South Kona, along the belt road. Lichens on the surface blocks are about all that is found. Elevation 1,600 feet. Photographed by W. Robyns.

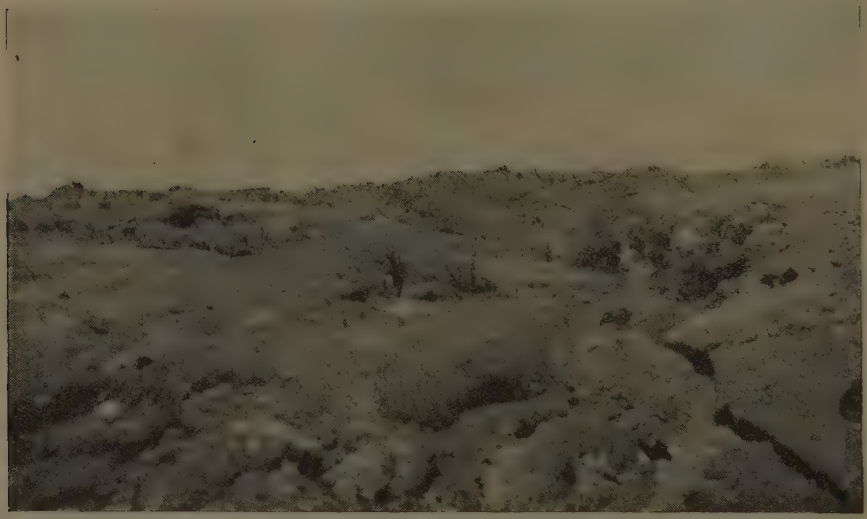


Fig. 33. — Second stage in colonization of lava flows in South Kona, 1868 flow. Note *Polypodium pellucidum, Nephrolepis exaltata* and *Sadleria cyatheoides* in cracks. Photographed by W. Robyns.

based his zones on what is to be found to day, without regard to the ultimate climatic climax which he admits cannot be determined at the present time.

The second reason his zonation will not fit the vegetation of the island of Hawaii, is found in the fact that on Oahu the *Acacia Koa* occurs below *Metrosideros collina* var. *polymorpha*, instead of above as it does on Hawaii. In the third instance, Oahu, due to its low altitude, shows none of the higher zones characteristic of Hawaii.

As has already been pointed out by Robyns (1938, p. 133 and 134), it is thus necessary to set up a new general classification of the altitudinal zones of the Island of Hawaii, which reads as follows (see Map, Fig. 13).

1. — Coastal-lowland zone :
   - A. Subzone of the rain forest, between 0 and 2,000 feet on the windward side and in Kona on the leeward side.
   - B. Subzone of the coastal shrub, between 0 and 1,500 feet on the leeward side.
2. — Transition forest zone, between 1,500 and 3,000-4,000 feet on the leeward side.
3. — Mountain forest zone, between 2,000 and 4,000 feet on the windward side and 2,500-6,000 feet on the leeward side.
4. — Parkland zone, up to the limit of tree-growth, about 7,000 feet.
   - A. Subzone of the plateau parkland in the interior.
   - B. Subzone of the mountain parkland on the windward side and on Hualalai.
5. — Subalpine shrub zone, between 7,000 and 9,000-10,000 feet.
6. — Alpine zone, above 9,000-10,000 feet.
7. — Bog zone, represented on the top of Mount Kohala by a few scattered bogs.

It is to be noted that the altitudinal zones are not always sharply marked but rather blend from one to the other.

PLANT SUCCESSION.

The study of the actual plant succession is of great importance for the knowledge of the developmental stages through which the vegetation passes in forming each climax. The work of Forbes (1912) has pointed the way to this type of work, for which the island of Hawaii offers an unusual favorable field. The present writers have tried to sum up the known data on succession and point the way to needed study.

Primary Succession.

Colonization of Lava Flows.

Lava flows are the most important initiators of primary succession on the island of Hawaii. Since the volcanoes are still active, large areas, covered with new layers of lava are completely devoid of vegetation. From this barren starting point, the waves of succession eventually produce a prisere, which culminates in the climax type of vegetation typical of the formation through which the flow advanced.

If the lava flow covers a portion of the dry side of the island, where rainfall may be less than 15 inches per year, it may take centuries for the various steps in succession to be completed. If, en the other hand, the flow occurs in the extremely wet forest, the steps follow quickly one on another, so that a new forest is produced within a short space of time.

These flows have been pouring over the landscape ever since the island began forming. The result is that on the present surface can be found lava flows of a great variety of ages. Since lava does not produce a very clear time scale, it is difficult to estimate the age of any given flow that occured before 1790. That date is the point from which historical records of the individual flows start. Since 1790, flows have covered portions of Hualalai, Mauna Loa, and Kilauea, flowing through parts of every major plant formation listed in the preceding classification, except the bog formation. These flows have been fairly well mapped, so that there is set up an unexcelled laboratory for the study of succession.

As mentioned in the introduction, Forbes (1912) began a study of the early steps in colonization. He published a preliminary

paper from notes gathered on a short trip to the island. No comprehensive report or study has been published since that time.

Forbes, who conducted his whole study on the lee slopes of the island, found that the character of the lava was a very important factor in the early colonization and later rate of succession. He found that, even though the surface of the *aa* flows were much more broken up and appeared to give more chance for plants to start, more plants were found on a *pahoehoe* flow of the same date. The major cracks on the *pahoehoe* seemed to catch soil building materials and produce a suitable site for plant life sooner than the many minute cracks on the *aa*.

The casual observer generally feels that succession follows through to the climax faster on the *aa* than on *pahoehoe*. Forbes believed that just the opposite is true. In a study of what is here termed the mountain parkland, immediately above the wet mountain forest, the *aa* flows are frequently forested, while the *pahoehoe* flows are grass covered. This has been brought about by grazing. The *pahoehoe* flows are easily penetrated by stock, with the result that overgrazing has destroyed the original vegetation, which has been replaced by a subclimax of grass. The *aa* is much harder to penetrate, resulting in much less complete destruction, with the result that the trees have survived. One may observe places where the climax *Acacia Koa* association has developed on a *pahochoe* flow, while an adjacent *aa* flow, perhaps of the same age, supports the developmental associes of *Metrosideros* and *Dodonaea*.

It appears, from observation and the work of Forbes, that the mosses and lichens are much more important in the early stages of succession on *aa* than on *pahochoe* (Fig. 32 and 33). These lichens are frequently found growing on an *aa* flow, while the adjacent *pahoehoe* supports many higher plants. Ferns are able to get a foothold on *pahoehoe* very quickly, as can be observed on the 1921 flow in Kilauea Crater (Fig. 35), where the following ferns grow in the small crevices: *Polypodium pellucidum, Nephrolepis exaltata, Pteris longifolia, Pellaea ternifolia,* together with a few species of flowering plants, such as *Rumex giganteus, Saccolepis contracta, Silene struthioloides* and *Dodonaea viscosa.* Seeds of *Metrosideros collina* var. *polymorpha* then are able to germinate on the ferns. From this foothold, roots spread over the smooth slabs of lava between the cracks, leaves and soil collect in the mesh of roots, and soon large sections are vegetated. With the coming of a plant

cover moisture holding capacity is increased, surface temperatures are lowered, so that the site gradually becomes less xeric. It soon is able to support a heavy plant growth, while adjacent *aa* is still in the very xerophytic lichen stage.

There has not been sufficient work done to trace the steps in succession in each of the major plant formations. This should prove a very interesting and fruitful field of study. A few of the steps in certain of the formations have been recognized, and, on the dry side of the island, Forbes gives the following:

« 1. Appearance of lower crytogams, eventually becoming conspicuous on *aa* (Fig. 32).

2. Appearance of *Polypodium pellucidum* (folded form), *Sadleria cyatheoides* and *Metrosideros polymorpha*, first on the *pahoehoe* (Fig. 33), and at a much later date on the *aa*.

3. Gradual development of the typical floral aspects of the immediate vicinity, if in the central region an Ohia forest.

4. Establishment of the final native vegetation, if in the central region a Koa forest.

5. A later stage may be the encroachment of the naturalized flora, due to a change of conditions brought about through human agency.»

Judging from his discussion, the central region of which Forbes speaks, is what is here termed the mountain parkland above the mountain forest, represented on this side of the island by a narrow strip. His observation that *Acacia Koa* is climax over *Metrosideros collina* var. *polymorpha,* in the mountain parkland zone, corroborates the present writer's observation in the same formation as it exists above Kilauea on Mauna Loa.

The writers have conducted a preliminary survey of plant invasion on the more recent lava flows near Kilauea crater. Lists were taken of the plants found adjacent to, on the edge of, and in the center of the various flow covered areas. The lists include all of the more common plants and many found only occasionally. Due to the extreme variation in rainfall, from 100 inches per year on the 1840 flow to perhaps less than 30 inches in the desert section, it is difficult to draw a comparative picture of the various flows.

The flows studied are the pre 1790 Keamoku flow and the 1920 flow in the desert section south west of Kilauea, the 1921 flow in

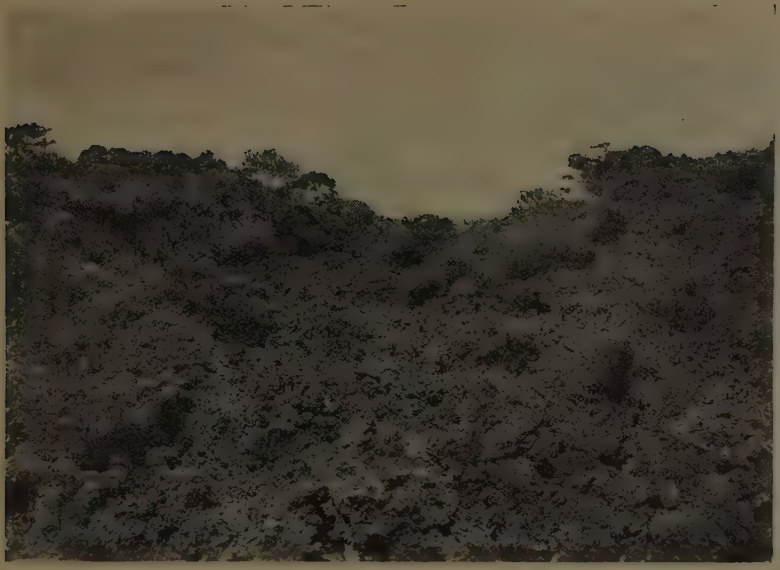


Fig. 34. — The pre 1790 Keamoku *aa* lava flow on the Southeast slope of Mauna Loa, sparsely covered with *Styphelia Tameiameia* and *Metrosideros collina* var. *polymorpha*. Elevation 3,500 feet. Photographed by S. H. Lamb.

Fig. 35. — Very smooth *pahoehoe* lava of the 1921 flow in Kilauea Crater. Elevation 3,650 feet. Pioneer plants in the cracks and on the thin layer of sand. Photographed by S. H. Lamb.

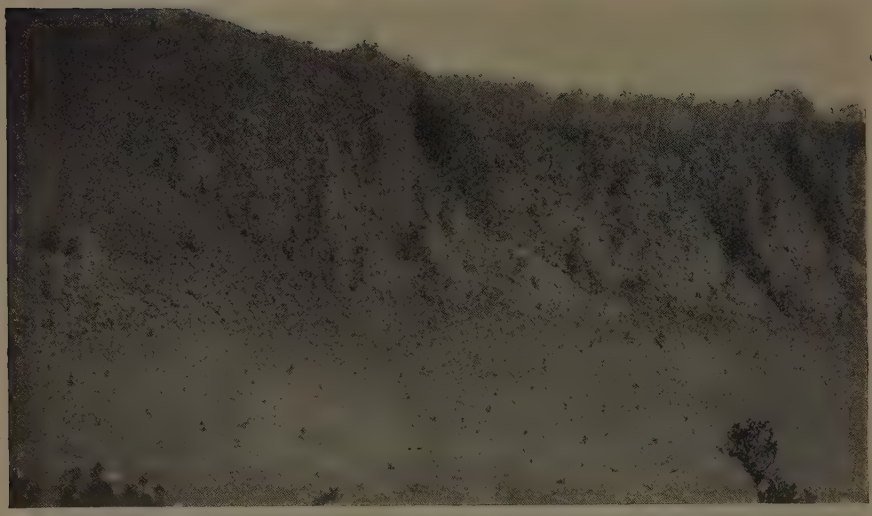


Fig. 36. — Floor of Keanakakoi Crater in Hawaii National Park, showing pioneer vegetation on the 1877 flow, consisting largely of *Metrosideros collina* var. *polymorpha*, *Sadleria cyatheoides*, *Polypodium pellucidum*, *Dodonaea viscosa* and *Silene struthioloides*. Elevation 3,450 feet. Photographed by W. Robyns.

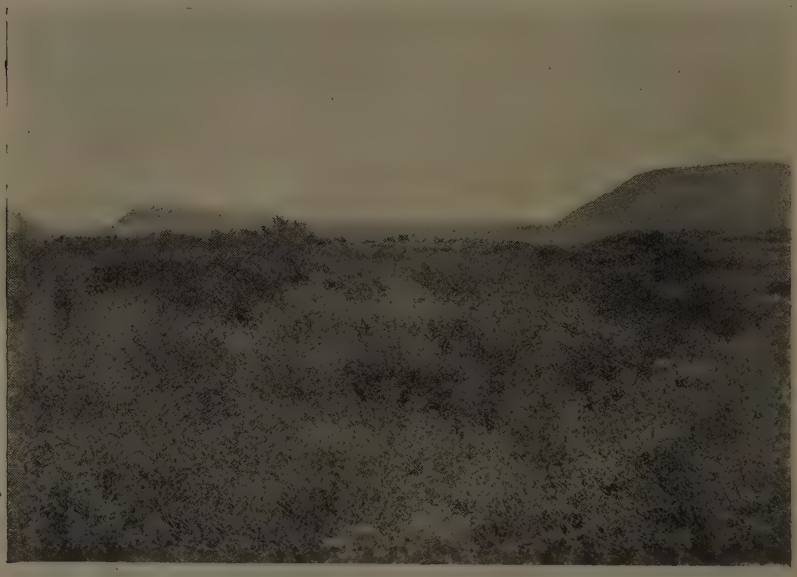


Fig. 37. — Secondary *Lantana Camara* association along belt road above Punaluu, overgrowing coastal-lowland shrub in overgrazed paddocks. Elevation 400 feet. Photographed by S. H. Lamb.

the floor of Kilauea crater, the 1877 flow on the floor of Keanakakoi crater adjacent to Kilauea crater but still in the dry region, and the 1840 flow near Napau crater in the wet region.

The Keamoku flow was studied at an elevation of 3,500 feet, where it crosses the belt highway, five miles south west of Park Headquarters at Kilauea. At this point it is a very rough *aa* flow not greatly weathered. It is thought to have occured not long previous to 1790. Rainfall is light, probably not over 30 inches per year, occuring generally as a few heavy rains. The adjacent area studied was a small « kipuka » missed by the Keamoku flow, two miles farther on, at an elevation of 3,000 feet. That « kipuka » is on the border line between the coastal-lowland shrub and transition forest and contains a few representative plants of each formation.

At the point where observations were made, this flow is very sparsely covered with plants of the *Metrosideros-Styphelia-Dodonaca* associes (Fig. 31). *Styphelia Tameiamcia* and *Dodonaca viscosa* have reached optimum development for this site, but *Metrosideros collina* var. *polymorpha* is still small and scattered. The « kipuka » that is older by at least one flow generation supports a much heavier forest growth, indicating what may be expected over the new flow at some future date.

The 1920 flow, known as Mauna Iki, is located nine miles south west of Park Headquarters and two and one half miles south of the belt highway, at an elevation of 3,000 feet above sea level. It is in the same climatic zone as the Keamoku flow. Its surface is smooth *pahoehoe* lava and it is surrounded by a flow of the same type that predates 1790.

Mauna Iki presents a very barren appearance. It is not until the observer approaches to within a few yards that any vegetation is observed. The present study was made at a place where the trade wind blows parallel to the edge of the flow. The light seeded *Dodonaca viscosa* is most noticeable, but like the other plants, occurs only in the cracks. Beyond fifty yards from the edge of the flow only a very few plants of any kind are found. Lichens are present at the edge of the flow but are very inconspicuous.

The 1921 flow is also of the *pahoehoe* type. The rainfall is nearly 50 inches per year, spread throughout the year. The elevation is 3,650 feet above sea level. The adjacent area is covered with a deep layer of the 1790 ash with most of the vegetation confined to sheltered banks. The number of plants listed is somewhat high, due

possibly to the presence of steam vents that make moisture conditions a little more favorable.

The vegetation of this flow gives the same general appearance as that on the 1920 flow (Fig. 35). The only difference is in the number of species represented. All of the plants are found in cracks, except in places where a thin layer of sand has been washed over the lava. In such places a few exotics such as *Erigeron albidus*, *Centaurium umbellatum* and a few grasses and sedges have become established. The plant life on the 1790 volcanic ash adjacent to this flow is more varied than that adjacent to the 1920 flow, due in part to more favorable moisture conditions. The only native flowering plant to have reached optimum development on this flow seems to be *Silene struthioloides*, which is particularly well adapted to invade new flows, where it reaches maturity long before the other perennials common to the region.

The 1877 flow is in the bottom of Keanakakoi crater at an elevation of 3,450 feet above the sea (Fig. 36). The surface is smooth *pahoehoe* that shows very little weathering. This crater is so close to the dividing line between the wet and dry regions that the northeast wall is much more moist than the south west fall. The list of plants from the adjacent area was taken on this moist side as was the list for the edge of the flow.

Here again this flow gives much the same appearance as the 1920 and 1921 flow, except that the individual plants are larger. With the exception of exotic plants confined largely to small outwash fans of gravel near the edge of the flow, the plants are confined to cracks. *Styphelia Tameiameia*, *Metrosideros collina* var. *polymorpha*, *Rumex giganteus*, and *Raillardia scabra* have reached fruiting size as well as *Silene struthioloides*.

Metrosideros collina var. *polymorpha* is not confined to growth on ferns although some seemed to be so associated. Moss and lichen growth is abundant only on the more moist north-east side.

The 1840 flow is located between Makaopuhi and Napau craters in the region of heavy rainfall, at an elevation of 2,900 feet. The lava is of the *pahochoe* type, showing very little weathering. It is nearly covered with a layer of soil and plant debris, so that many of the normal depressions in the surface are filled. This soil is almost constantly saturated with water from the drip of 100 inches of rain per year.

A three storied forest is rapidly developing on this flow. The

ground is covered with a mat of moss and small flowering plants. Above this is an almost impenetrable tangle of *Gleichenia emarginata,* growing vine like into the *Metrosideros collina* var. *polymorpha* trees that form the overstory. The trees have reached a height of 15 to 25 feet. *Styphelia Tameiameia* and *Dodonaea viscosa*, typical of the dryer Keamoku flow, are almost entirely lacking, perhaps crowded out by the *Gleichenia emarginata*. It was not possible to find a suitable younger flow in the wet region to see if the *Dodonaea-Styphelia* associes could be found. The associes represented on this flow might be called *Gleichenia-Metrosideros*.

The plants on the adjacent area, with its much better developed soil, included the genera typical of the mountain forest *Metrosideros-Cibotium* association, including *Gouldia, Ilex, Cheirodendron, Pelea*, and *Cibotium*. These genera are still minor components of the community, however.

The tabulation of the plants found on the various lava flows and adjacent areas includes all of the common plants and many found only occasionally. The presence and relative abundance of each plant is indicated by a symbol. The total number of times each plant was found is given as well as the number of species on each flow (See p. 284).

A study of the tabulation will show that the 1920 flow has been invaded the least and the 1921 the most. The reason for the sparse invasion, poor in species, on the 1920 flow may be due to the fewer plants on the adjacent area as well as the extreme dryness of the region, while, as has already been stated, moisture conditions are more favorable on the 1921 flow. The 1840 flow shows no more species than the 1877 flow, but the relative abundance of plants is much greater. The older Keamoku flow, located in the very dry region, is the poorest in number of species and relative abundance. while the younger 1840 flow, in a very wet locality, is highest in abundance and some higher in number of species.

The fact that these flows are not all in the same plant formation makes it difficult to draw any conclusions, but, in general, the wetter the region the greater is the abundance of plant life and the higher the number of species. That the amount of moisture is more important than the age of the flow is shown by the contrast between the 1840 and pre 1790 Keamoku flow, and between the 1921 and 1920 flow.

In general this study supports the findings of Forbes. Perhaps

TABULATION AND ABUNDANCE OF PLANTS FOUND IN FIVE AREAS NEAR KILAUEA CRATER

Check List of Plants on or adjacent to lava flows	Keamoku Pre 1790	Adjacent to Keamoku	1840	Adjacent to 1840	Edge of 1877	Center of 1877	Adjacent to 1877	Edge of 1920	Center of 1920	Adjacent to 1920	Edge of 1921	Center of 1921	Adjacent to 1921	N° of times Plant occured
Moss	M	M	A	A	M	—	M	—	—	O	M	M	M	10
Lichen	M	M	A	A	M	O	M	O	—	O	O	O	O	12
Selaginella	—	—	M	M	—	—	—	—	—	—	—	—	—	2
Psilotum nudum	—	—	M	M	O	O	O	—	—	—	—	—	—	5
Lycopodium cernuum	—		A	A	—	—	—	—	—	—	—	—	—	2
Pteridium aquilinum	O	M	—	—	—	—	O	—	—	—	—	—	—	3
Pellaea ternifolia	O	M	—	—	O	—	O	O	—	O	O	O	O	9
Polypodium pellucidum	—		—	—	M	M	M	O	O	O	M	M	M	9
Sadleria cyatheoides	—	O	M	A	O	O	M	—	—	—	O	O	M	9
Nephrolepis exaltata	—	—	—	M	M	M	M	—	—	—	O	O	M	7
Gleichenia emarginata	—	—	A	A	—	—	O	—	—	—	—	—	—	3
Polypodium linearе	—	—	—	—	—	—	O	—	—	—	—	—	—	1
Polypodium sarmentosum	—	—	—	—	—	—	—	—	—	—	O	—	O	2
Pteris cretica	—	—	—	—	—	—	—	—	—	—	O	—	O	2
Pteris longifolia	—	—	—	—	—	—	—	—	—	—	O	M	O	3
Elaphoglossum hirtum	—	—	—	—	—	—	O	—	—	—	—	—	—	1
Elaphoglossum conforme	—	—	M	M	—	—	M	—	—	—	—	—	—	3
Sphenomeris chusana	—	—	—	—	—	—	O	—	—	—	—	—	—	1
Gahnia Gaudichaudii	M	M	—	—	O	O	O	—	—	—	—	—	—	5
Vincentia angustifolia	—	—	M	A	—	O	O	—	—	—	—	—	—	4
Other sedges	—	—	—	—	—	—	—	O	—	M	M	M	M	5
Briza minor	—	—	—	—	—	—	O	—	—	—	—	—	—	1
Cenchrus echinatus	—	A	—	—	—	—	—	O	—	A	—	—	—	3
Other grasses	—	O	—	—	—	—	O	—	—	—	O	O	O	5
Dianella sandvicensis	O	M	—	—	—	—	O	—	—	—	O	—	O	5
Astelia veratroides	—	—	—	A	—	—	—	—	—	—	—	—	—	1
Smilax sandvicensis	—	—	M	M	—	—	—	—	—	—	—	—	—	2
Peperomia sp.	—	—	—	M	—	—	—	—	—	—	—	—	—	1

Cyrtandra platyphylla	—	—	—	A	—	—	—	—	—	—	—	—	—	1
Portulaca sclerocarpa	—	—	—	—	—	—	—	—	—	—	—	—	M	1
Silene struthioloides	—	—	—	—	M	—	M	—	—	—	M	O	M	5
Rumex giganteus	—	O	—	—	M	O	M	—	—	—	O	—	M	6
Raillardia scabra	—	—	M	M	O	O	O	—	—	—	O	O	O	8
Raillardia laxiflora	O	M	O	M	O	O	M	—	—	—	O	O	O	10
Bidens pilosa	—	O	—	—	—	—	—	O	—	O	—	—	—	3
Coprosma ernodioides	—	—	M	M	—	—	M	—	—	—	—	—	M	4
Erigeron albidus	O	M	—	—	—	O	M	O	—	O	M	M	M	9
Centaurium umbellatum	—	—	—	—	O	—	—	—	—	—	M	O	M	4
Vaccinium reticulatum	O	O	O	M	O	O	M	—	—	—	O	O	M	10
Vaccinium calycinum	—	—	M	M	—	—	—	—	—	—	—	—	—	2
Kadua glomerata	—	—	—	M	—	—	—	—	—	—	—	—	—	1
Osteomeles anthyllidifolia	O	M	—	—	—	—	—	—	—	—	—	—	—	2
Dodonaea viscosa	M	A	—	—	O	O	M	M	O	A	O	O	M	11
Styphelia Tameiameia	M	A	O	—	O	O	M	M	O	A	O	—	M	11
Wikstroemia sandwicensis	—	O	—	M	—	—	—	—	—	—	—	—	—	2
Clermontia hawaiiensis	—	—	—	O	—	—	—	—	—	—	—	—	—	1
Sida fallax	—	M	—	—	—	—	—	—	—	—	—	—	—	1
Broussaisia sp.	—	—	—	M	—	—	—	—	—	—	—	—	—	1
Freycinetia arborea	—	—	—	M	—	—	—	—	—	—	—	—	—	1
Gnaphalium japonicum	—	—	—	—	—	O	O	—	—	—	—	—	—	2
Metrosideros collina var. *polymorpha*	M	M	A	A	O	O	M	O	O	A	O	O	M	13
Sophora chrysophylla	—	M	—	—	—	—	—	—	—	—	—	—	—	1
Gouldia terminalis	—	—	—	M	—	—	—	—	—	—	—	—	—	1
Pelea clusiaefolia	—	—	—	O	—	—	—	—	—	—	—	—	—	1
Suttonia Lessertiana	—	—	—	M	—	—	—	—	—	—	—	—	—	1
Ilex sandwicensis	—	—	—	O	—	—	—	—	—	—	—	—	—	1
Cheirodendron Gaudichaudii	—	—	—	O	—	—	—	—	—	—	—	—	—	1
Cibotium Chamissoi	—	—	—	A	—	—	—	—	—	—	—	—	—	1
Total Plants Found.	13	21	17	32	17	16	29	10	4	11	22	17	24	—

A = Abundant; M = Moderate number; O = Occasionally found.

less stress should be placed on his first two steps in succession, namely the appearance of lower cryptogams and then the fern stage. In the Kilauea area, succession appears to start off directly with the higher plants, supported by the cryptogams. In almost every case, species of *Dodonaea, Styphelia* and *Metrosideros* are more important than the other plants. The development of moss and lichen is very secondary, except in the wet forest where a carpet of moss eventually forms as conditions become less xeric.

In summary, study of the Kilauea region shows invasion progressing as follows:

1. Invasion of the cracks in the new flow by ferns and flowering plants common to the adjacent area, and supported by cryptogams especially on the *aa* lava.
2. Gradual building up of a heavier plant covering, filling in between the cracks, producing a shrub stage in which *Dodonaea viscosa, Styphelia Tameiameia,* and *Metrosideros collina* var. *polymorpha* predominate.
3. Production of a plant community typical of the formation found on the adjacent area.

Secondary Succession.

Colonization of Cleared Areas.

While lava flows are the greatest producers of barren areas where steps in succession may be followed from the very start, human activity produces many clearings that are later abandoned. In general it may be said that, due to the fact that soil, of more or less depth, is present on these sites, the steps in succession form a subsere and start with higher forms of plant life than on the barren lava. With this start, the steps generally follow through faster, producing the climax in a shorter time.

At the present time, it is very difficult to get a clear picture of what would take place on these cleared fields under natural conditions, as recently introduced exotics move into and take possession of the area before native plants can get a foothold. In observing many abandoned fields in the Kona district, the first stage appeared to be herbaceous weeds. Some of the more conspicuous plants noticed were *Erigeron albidus,* very plentiful and one of the first to appear, *Salvia coccinea, Verbena, Bidens, Opuntia megacantha* and several grasses. This stage is followed by the more

Fig. 38. — Secondary *Psidium Guajava* association on cleared land, above Kailua, along belt road. Notice *Aleurites moluccana* on left, indicator of the climax formation. Elevation about 1,500 feet. Photographed by W. Robyns.

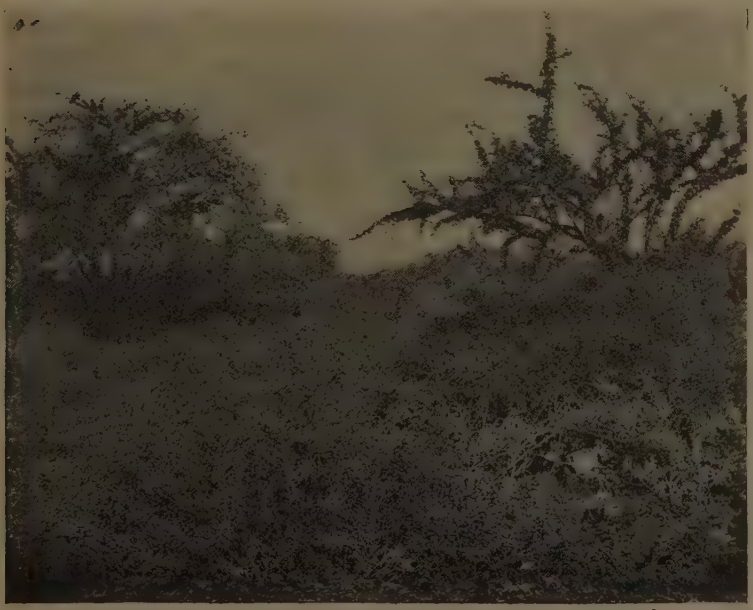


Fig. 39. — Secondary leguminous association along beach road, between Napoopoo and Honaunau. Mixed legumes replacing *Lantana Camara*. Photographed by S. H. Lamb.

Fig. 40. — Secondary *Tricholaena repens* association along belt road, in Waimea section of South Kohala. *Dodonaea viscosa*, *Wikstroemia* sp., *Sida fallax* and scattered *Metrosideros collina* var. *polymorpha* indicate a forest climax. Elevation about 2,700 feet. Photographed by W. Robyns.

Fig. 41. — Badly overgrazed area in transition zone between transition forest and mountain parkland, Golf Course, Hawaii National Park. Notice decadent *Acacia Koa* to right and *Metrosideros collina* var. *polymorpha* to left, lack of reproduction, and understory of introduced grasses. Photographed by W. Robyns.

shrub-like plants, including *Lantana Camara, Sida fallax*, and *Opuntia megacantha. Lantana Camara* frequently becomes so well established (Fig. 37), particularly in the lower and dryer sites, that it is hard for a more advanced stage to be initiated. In certain higher and wetter areas, where *Lantana* does not gain such a firm foothold, the next stage is almost pure stands of *Psidium Guajava*, (Fig. 38).

Large sections of the coastal-lowland forest have been taken over by *Psidium Guajava*. It appears that, in some cases at least, *Aleuritis moluccana,* Kukui, may be able to replace this Guava sub climax to form the true climax association.

It is in connection with these areas taken over by *Lantana Camara* and *Psidium Guajava* that successional studies are needed most urgently. It is a grave economical problem to know what to do, because the plants themselves are not only worthless but very hard to control. At the present time, land taken over by these exotics is lost so far as agricultural value is concerned, unless the land is sufficiently valuable to justify hand clearing. If natural plant succession can be expected to control these pests, even though it be a long time process, it brightens the outlook for the future value of much submarginal land. It is barely possible that some native or introduced tree may be found that can successfully compete with and eventually crowd out these plants, thus producing a marketable product in the form of forest products. Some observers believe that *Leucaena glauca,* Haole Koa, and other legumes, can replace *Lantana Camara,* thereby raising the value of the land for grazing (Fig. 39).

Relation of Grazing to Plant Succession.

Although lava flows and clearing have been the chief initiators of succession from a bare site, grazing has affected more of the islands vegetation than all other causes. Grazing, either by domestic or feral mammals has, with perhaps a few minor exceptions, affected to some degree all of the vegetation on the island. Some portions, particularly the dryer exposures, have undergone complete alteration, with many exotic plant species now firmly established over large areas. Parts of the mountain forest have been affected the least. Lamb (1938) has shown the effects of goat grazing in portions of the Hawaii National Park.

Large expanses of the transition forest and mountain parkland have been so badly overgrazed for so long that the original cover is gone. A few old and broken trees are the only remanents of what originally grew there (Fig. 40 and 41). These areas are now being held in a subclimax of grass and forbs. Over large paddocks the native brush is purposely destroyed and grasses and forage plants introduced. Natal grass or red top, *Tricholaena repens,* is spreading over much of the transition forest zone (Fig. 40), while *Paspalum conjugatum,* Hilo grass, and others have been distributed over parts of the mountain forest. *Axonopus compressus* is said to be crowding out the Hilo grass in Waimea, while *Sporobolus capensis* invades overgrazed parts of the same region.

Another unusual effect of grazing has been the spread of a new forest association, as the *Prosopis juliflora* of the coastal-lowland shrub. Thousands of acres through Kau, Kona and Kohala are now covered with dense stands. Its value to live stock is high, the beans producing a very good food. Many other leguminous plants are associated.

Opuntia megacantha covers many acres of the transition forest zone. It does not form dense enough cover to exclude all other plants, many small shrubs and forbs being found. The following are some of the more common plants seen along the road south of the 1801 flow in Kona: *Erigeron albidus, Salvia coccinea, Stachytarpheta jamaicensis, Bidens pilosa, Desmodium uncinatum, Indigofera anil, Opuntia megacantha, Cassia occidentalis* and *C. mimosiodes, Physalis peruviana, Verbena bonariensis, Asclepias curassavica, Euphorbia indica, Sporobolus capensis,Cenchrus echinatus, Tricholaena repens,* and *Pennisetum Ruppelii.*

In the mountain forest and parkland above it, grasses have invaded much of the area formerly covered by trees and shrubs (Fig. 42). It is here that Forbes (1912) found so much damage in 1912. Much of the forest on the slopes of Mauna Kea has been converted to rather open parkland.

In many places the original cover, with modifications, might return naturally if grazing were prohibited, but portions of the transition forest are probably too fare gone to ever make a satisfactory come back. The ability of *Metrosideros collina* var. *polymorpha* to recover is shown in places where grazing has been eliminated by fencing. Several areas in the National Park fenced in 1935 illustrate this fact (Fig. 43).

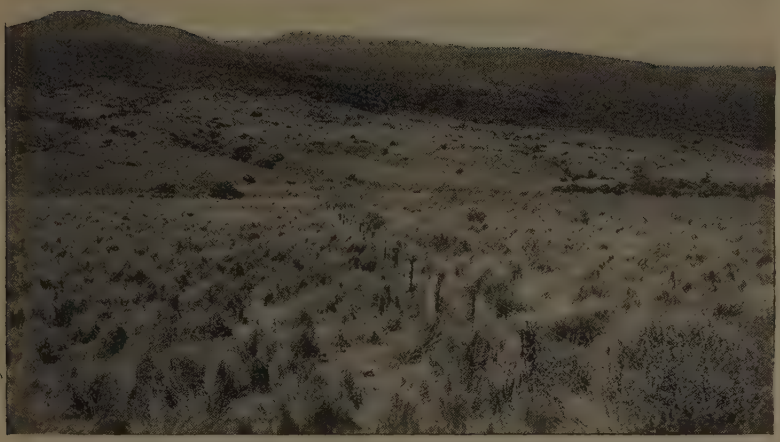


Fig. 42. — Overgrazing in the *Chenopodium association* of the Plateau Parkland along road to Humuula. Note lack of *Chenopodium sandwicheum* to left and presence of it to right. Elevation about 5,500 feet. Photographed by S. H. Lamb.

Fig. 43. — Result of overgrazing in transition forest, Gold Course, Hawaii National Park. Notice heavy reproduction of *Metrosideros collina* var. *polymorpha* on right, where grazing was eliminated since 1935. Elevation 4,000 feet. Photographed by S. H. Lamb.

Effects of Exotic Plants on the present System of Formations.

In some areas, the entrance of exotic plants that have become quite throughly naturalized is having a tremendous effect on the native vegetation. In certain places it appears that new climaxes are being established. It is still too early to make definite statements, but it seems quite certain that *Prosopis juliflora* will form a forest climax on much of the land classed as coastal-lowland shrub.

As stated above, many areas are being held in subclimaxes, by grazing, that might revert to their true climax if given protection. Due to the persistent invasion of exotic grasses where grazing occurs, it seems very likely that large sections in the transition and mountain forest and moutain parkland will be held as grass or parkland subclimax. If one accepts the belief that this grassland would revert to its true climatic climax if given sufficient time and protection, then it can never be classed as climax.

Agricultural land that has been abandoned and is being held in a *Lantana Camara* or *Psidium Guajava* subclimax should progress to a climax of taller, more woody plants, if allowed to remain unmolested long enough.

CONCLUSION.

Thus we see that lava flows and human interference are playing a very important role in the vegetative picture of the island of Hawaii, making it actually very complex. The numerous lava flows are narrow enough so that they will be revegetated with the materials that surround them. On the other hand, introduced plants will continue to play a very major role in plant succession. It is already impossible to recognize the original climax type over much of the island. As exotics spread, new climaxes may be formed as all factors come into balance. It will take many years of careful observation to tell what the final outcome will be.

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REVISION

DES

ESPÈCES CONGOLAISES

DU

GENRE TETRACERA L.

PAR

P. STANER.

Le genre *Tetracera* est le seul représentant africain de la famille des *Dilléniacées*. Parmi les quelques dix espèces décrites, il y en a sept au Congo belge.

A part le *T. Masuiana*, qui est une plante dressée croissant dans les savanes, toutes les autres espèces congolaises sont des lianes de grandes dimensions assez communes en forêt et en galerie forestière.

L'intérêt de ces lianes réside dans le fait que, sectionnées, elles laissent exsuder une sève fraîche et abondante, très appréciée des voyageurs altérés.

De Wildeman (1) a parlé de ces lianes dans une étude qu'il fit sur les plantes utilisées contre la soif par les indigènes. D'après cet auteur, aucun récolteur congolais n'aurait remarqué les propriétés aquifères du *T. potatoria* très connu comme « liane-robinet » dans toute l'Afrique tropicale occidentale. Boone cependant signale que dans l'Uele, ces propriétés sont connues et appréciées. Mais si

(1) De Wildeman, Plantes pour la soif. — *Bull. Inst. Roy. Col. Belge*, V, pp. 131-157 (1934).

les *Tetracera* ne sont guère exploités par les indigènes ou les Européens, il n'en est pas de même d'autres lianes jouissant des mêmes propriétés. De Wildeman (l. c.) ne signale pas moins de 12 espèces. Nos recherches récentes nous permettent d'ajouter 6 nouveaux noms à cette liste, à savoir : deux *Connaracées : Byrsocarpus viridis* (Gilg) Schell. et *Yaundea Oddoni* (De Wild.) Schell., une *Légumineuse : Dalhousiea africana* Don, une *Anacardiacée : Sorindeia Lemairei* De Wild. et une *Passiflorée : Adenia lobata* (Jacq.) Engl.

Si beaucoup d'auteurs et de récolteurs ont signalé cette sécrétion, nous n'en connaissons aucun qui en ait défini la composition chimique, pas plus que les éléments qui la conditionnent.

L'étude de cette question mériterait d'attirer l'attention des chercheurs du Congo belge. Il serait peut-être possible d'établir une relation entre la présence d'eau dans les *Tetracera* et la nature du terrain dans lequel ils poussent.

Les *Tetracera* sont intéressants à d'autres points de vue. Nombreux sont les récolteurs qui insistent sur la suavité du parfum dégagé par les fleurs. Au moment où l'on pousse l'étude des plantes congolaises à parfum, il ne serait pas sans intérêt de procéder à des distillations de fleurs, pour apprécier la nature et la valeur de ce parfum.

D'ailleurs les *Tetracera* peuvent retenir l'attention des chimistes en ce qui concerne les propriétés thérapeutiques de ces plantes très connues des nègres de l'Afrique tropicale occidentale. Dalziel (1) signale que les feuilles de toutes les espèces sont employées contre la dysenterie. Le *T. alnifolia* serait connu comme stupéfiant pour le poisson et contiendrait un glucoside, tandis que le *T. potatoria* serait employé contre les rhumes, les maux de dents et les maladies vénériennes. Dans notre travail sur les plantes médicinales (2) nous signalons plusieurs utilisations médicinales par les indigènes du Congo ; il est intéressant de noter que les 4 espèces citées sont employées dans diverses régions pour soigner les maladies de la peau.

(1) Dalziel, *The useful Plants of West Tropical Africa*, p. 44, 1937.
(2) Staner et Boutique, Matériaux pour l'étude des plantes médicinales indigènes. — *Inst. Roy. Col. Belge, Sect. Sc. Nat. et Méd.*, Mém. in-8°, V, 6, p. 126 (1937).

Synopsis des espèces et variétés.

I. Plantes suffrutescentes, dressées, n'atteignant pas plus d'un m. de hauteur. Inflorescences en cymes pauciflores. Sépales densément velus à la face extérieure ... ... 1. *T. Masuiana.*

II. Lianes ligneuses ordinairement très grandes. Inflorescences en panicules multiflores. Sépales glabres ou exceptionnellement velus à la face extérieure:

A. Feuilles scabres sur les 2 faces, rèches au toucher. Sépales soyeux à la face interne. Carpelles et fruits velus ... ... 2. *T. potatoria.*

B. Feuilles non scabres sur les 2 faces. Sépales soyeux ou glabres à la face interne. Carpelles et fruits velus (mais alors, sépales glabres à la face interne) ou glabres:

1. Sépales soyeux à la face interne:

a. Feuilles oblongues-lancéolées, elliptiques, cunéiformes à la base, aiguës ou acuminées au sommet; sépales courtement soyeux à la face interne:

α. Pétales ayant en moyenne 10-13 mm. de long... 3. *T. Poggei.*

β. Pétales ayant en moyenne 18-20 mm. de long 4. *T. rosiflora.*

b. Feuiles obovales, arrondies ou parfois obtuses à la base, arrondies ou cuspidées au sommet; sépales très densément et longuement velus à la face interne. Pétales de 18-22 mm. de long ... ... 5. *T. Claessensii.*

2. Sépales glabres à la face interne:

a. Carpelles et fruits glabres:

α. Face inférieure des feuilles et pétioles glabres ... ... 6. *T. alnifolia.*

β. Face inférieure des feuilles et pétioles velus ... ... *T. alnifolia* var. *podotricha.*

b. Carpelles et fruits velus ... ... 7. *T. Dinklagei.*

Énumération des espèces.

1. — **Tetracera Masuiana** *De Wild.* et *Th. Dur.*, Ill. Fl. Cgo, p. 61 (1899) ; *Th.* et *Hél. Dur.*, Syll., p. 16 (1909) ; *De Wild.*, C^ie^ Kasaï, p. 354 (1910) ; id. Ann. Mus. Cgo, série V, III, p. 445 (1912) ; id., Bull. Jard. Bot. État, Brux., V, p. 360 (1919) ; id., Pl. Bequaert., I, p. 151 (1921) ; *De Wild.* et *Stanер*, Contr. Fl. Kat., Suppl. IV, p. 65 (1932).

T. Masuiana var. *Sapini* De Wild. in C^ie^ Kasaï, p. 354 (1910).

T. strigillosa Gilg in Engl., Bot. Jahrb., XXXIII, p. 196 (1902).

District du Bas-Congo : env. de Lemfu, 1900, *Gillet* et *Butaye* 1210 ; Kisantu-Makele, 1903, *Gillet* et *Van Houtte* 3453 et 3664 ; entre Kisantu et le Kwango, 1904, *Gillet* et *Butaye ;* Kisantu, 1911, *Vanderyst ;* Taka-Kisantu, 1914, *Vanderyst* 3397 ; Vinda, 1915, *Vanderyst* 5727.

District du Kasaï : Kwilu, 1907, *Sapin ;* Koma, 1909, *Allard* 27 ; Kindingi, 1910, *Allard* 431 ; Luluabourg, 1921, *Ghesquière ;* Mbondo, 1924, *Vanderyst* 13817 ; Panzi, 1925, *Vanderyst* 16991 ; Kasongo-Lunda, 1925, *Vanderyst* 17536 ; Luluabourg, 1930, *Vanderyst* 21065, 21073, 21262, 21267, 23986 et 24001 ; entre Popokabaka et Kasongo-Lunda, 1931, *Lebrun* 119 ; Luluabourg, 1933, *Lynes* 104 ; Kapanga, 1933, *Overlaet* 824, 825, 1027 et 1028 ; Gandajika, 1935, *Matagne* 94 et 262.

District du Bas-Katanga : bords du Lomami, 1895, *É. Laurent ;* Lubunda, 1896, *Dewèvre* 1025 (type) ; Kanda-Kanda, 1902, *Gentil* 75 ; Dilolo, 1908, *Sapin ;* Pastorale du Lomami, section Lualu, 1931, *Quarré* 2795 ; Kabalo, 1931, *Luxen* 64 ; Luputa, 1933, *Bouvier* 71.

District du Haut-Katanga : Kisengwa, 1922, *De Giorgi* 161.

District du Haut-Ubangi et Uele : région de Bondo, 1935, *Dewulf* 749.

Noms vernaculaires : Kakalamkwari (dial. Kiluba, fide *Ghesquière*) ; Kaliantaba (dial. Kilua, fide *Ghesquière*) ; Kaloume (Tanganika, fide *Dewèvre*) ; Tshiluba n' kassu (= le casseur de houes) (dial. Tshiluba, fide *Ghesquière*) ; Ditonto ou Ditonte (dial. Tshiluba, fide *Ghesquière*) ; Kakela n'kwari ou Mutonte (= celle qui fatigue les perdrix) (dial. Bena Kosh, fide *Ghesquière*).

Observations. — 1. — Ce *Tetracera* suffrutescent est assez répandu dans toutes les savanes de l'Afrique tropicale.

2. — L'examen d'un matériel très abondant nous a montré toutes les gradations entre les feuilles très densément velues et celles presque glabres. Nous ne pensons donc pas pouvoir retenir le *T. strigillosa* dont la différence avec le *T. Masuiana* était uniquement basée sur la plus ou moins grande quantité de poils des feuilles.

2. — **Tetracera potatoria** *Afz.* ex *Don,* Gen. Syst., I, p. 69 (1831) ; *De Wild.,* Ann. Mus. Cgo, série V, III, p. 445 (1912) ; id. Pl. Bequaert., I, p. 205 (1921).

T. obtusata Planch. ex Oliv., Fl. Trop. Afr., I, p. 12 (1868).

T. Stuhlmanniana Gilg in Engl., Pflanzenw. Ostafr., C., p. 272 (1895).

T. Stuhlmanniana var. *occidentalis* De Wild., Mission Laurent, 1907, p. 410 ; id., Bull. Jard. Bot. État, Brux., V, p. 360 (1919) ; id., Ann. Mus. Cgo, série V, III, p. 445 (1912) ; Th. et Hél. Dur., Syll., p. 17 (1909).

District Forestier Central : Umangi, 1904, *Krekels ;* environs d'Eala, 1905, *Pynaert* 85 ; rives de l'Itimbiri et du Ruki, 1905, *Seret* 41 ; Kasuku, 1910, *Claessens* 632 ; Mogandjo, 1910, *Claessens* 655 ; Nala, 1911, *Boone* 64 ; Barumbu, 1913, *Bequaert* 1016 ; Yambuya, 1913, *Bequaert* 1244 ; Banalia, 1913, *Bequaert* 1423 ; Barumbu, 1920, *Claessens* 19 ; id., 1921, *Goossens* 2552 ; île en face de Coquilhatville, 1925, *Robyns* 762 ; entre Amadi et Poko, 1931, *Lebrun* 3023 ; La Kulu, 1931, *Vanden Brande* 217 et 719 ; environs de Bambesa, 1934, *Bredo* 432 et 530 ; id., 1936, *Pittery* 324, 325 et 326 ; environs de Bondo, 1934, *Dewulf* 140 ; Yangambi et environs, 1937, 1938, *Louis* 7508, 8743, 9348, 9690, 10157, 10738, 11424 et 11471.

District du Lac Albert : entre Bunia et Gety, vers 1,550 m. d'alt., savane, 1931, *Lebrun* 4045.

Noms vernaculaires : Bokosaka (dial. Turumbu, fide *Louis*) ; Songo (dial. Lingala, fide *Goossens*) ; Lomange (dial. Mongandu, fide *Claessens*) ; Mokwekwe (dial. Mogandjo, fide *Claessens*) ; Wanza (dial. Kundu, fide *Robyns*).

Observations. — 1. — Cette grosse liane de forêt est très reconnaissable à première vue à la rugosité des feuilles. Celles-ci peuvent être obovales ou ovales et arrondies, obtuses ou aiguës à la base sur un même spécimen. Nous ne pensons donc pas qu'il soit opportun de conserver le nom de *T. Stuhlmanniana* dont l'originalité était basée sur la forme des feuilles arrondies à la base.

2. — L'aire de dispersion de cette espèce est assez vaste : elle s'étend depuis le Golfe de Guinée jusqu'aux environs du Lac Victoria, mais toujours au Nord de l'Équateur.

3. — **Tetracera Poggei** *Gilg* in Notizbl. Bot. Gart. u. Mus. Berlin, I, p. 71 (1895) ; *Th.* et *Hél. Dur.*, Syll., p. 17 (1909) ; *De Wild.*, Cte Kasaï, p. 354 (1910) ; id., Ét. Fl. Bangala et Ubangi, p. 350 (1911) ; id., Ann. Mus. Cgo, série V, III, p. 231 (1912) ; id., Bull. Jard. Bot. État, Brux., IV, p. 165 (1914) ; id., Pl. Bequaert., I, p. 151 (1921) ; *Gilg* in *Engl.*, Bot. Jahrb., XXXIII, p. 198 (1902).

T. fragrans De Wild. et Th. Dur., Ill. Fl. Cgo, I, 3, p. 55 (1899).

T. Gilletii De Wild., Ann. Mus. Cgo, série V, I, p. 290 (1906).

T. rosiflora De Wild. in Ann. Mus. Cgo, série V, III, p. 231 (1912) (non Gilg).

District du Bas-Congo : Kisantu, 1900, *Gillet* 807 ; id. 1900, *Gillet* 1826 ; id., 1901, *Gillet ;* Kimuenza, 1901, *Gillet* 2183 ; id., 1900, *Gillet ;* Kisantu, 1903, *Gillet* 3065 ; Sanda, 1903, *Gillet* 3566 et 3613 ; Kimpako, 1908 et 1909, *Vanderyst ;* Kisantu, 1911, *Vanderyst ;* Léopoldville, 1915, *Bequaert* 7326 ; Kimpako, 1924, *Vanderyst* 13626, 13674 et 14595 ; Mpese, 1933, *Vanderyst* 39039.

District du Kasaï : Mukenge, 1881, *Pogge* 605 (type) ; Bienge, 1907, *Sapin* C 40 ; Munungu, 1910, *Sapin ;* Luebo, 1920, *Achten* 202 B ; dans la Benga, 1925, *Vanderyst* 14920 ; Mérode, 1930, *Vanderyst* 23283 et 23393bis ; Bumbuli, 1932, *Lebrun* 6505 ; Kabambaie, 1933, *Lynes* 183 A.

District Forestier Central : Bumba, 1896, *Dewèvre* 887 ; Avakubi, 1914, *Bequaert* 1969 ; Lisala-Upoto, 1925, *Robyns* 946.

Noms vernaculaires : Bojo (dial. Lingala, fide *Sapin*) ; Lemi ekabe (Lisala, fide *Robyns*) ; Moji, Mutonte ou Monji a Musongo (= liane de la cime des arbres) (dial. Tshiluba, fide *Ghesquière*).

Observations. — 1. — Cette espèce est facilement reconnaissable à ses petites fleurs. Les sépales mesurent en moyenne de 6 à 8 mm. de long et de 5 à 7 mm. de large ; parfois, mais rarement, ils atteignent de 8 à 10 mm. de long et de 7 à 9 mm. de large. Les pétales ont de 10 à 13 mm. de long et de 8 à 9 mm. de large ; 1 spécimen sur 12 nous a montré des pétales atteignant 13 à 15 mm. de long. Gilg, dans son travail sur les *Tetracera* (op. cit., p. 195), différencie le *T. Poggei* Gilg du *T. rosiflora* Gilg en se basant sur les feuilles et les pétales. Les feuilles du *T. Poggei* ne seraient pas dentées, celles du *T. rosiflora* le seraient manifestement. Cette

différence ne peut pas être retenue ; nous avons vu des spécimens présentant les deux types de feuilles sur le même plant. Quant aux pétales, ceux du *T. Poggei* seraient tronqués au sommet et ceux du *T. rosiflora* échancrés. Quand on compare les descriptions originales de ces deux espèces, on pourrait admettre le bien-fondé de l'opposition basée sur ce caractère. Mais l'examen des types montre que dans les deux cas les pétales sont échancrés. La seule vraie différence existant à notre sens entre ces deux espèces réside dans la longueur des pétales : le *T. rosiflora* a des pétales de 20-22 mm. de long, le *T. Poggei*, des pétales de 10-13 mm. et exceptionnellement de 15 mm. de long.

2. — Le *T. Poggei* semble endémique au Congo ; il croît dans les savanes du Bas-Congo et du Kasaï et dans quelques régions de la forêt équatoriale.

4. — **Tetracera rosiflora** *Gilg* in *Engl.*, Bot. Jahrb., XXXIII, p. 199 (1902).

District du Bas-Katanga : entre Katakokombe et Lodja, savane, 1932, *Lebrun* 6165 ; Kapanga, 1933, *Overlaet* 1025.

Observation. — Cette espèce est assez répandue en Angola ; son aire géographique s'étend jusqu'au Maniema, et il est vraisemblable qu'on la retrouve au Kasaï

5. — **Tetracera Claessensii** *De Wild.* in Bull. Jard. Bot. État, Brux., III, p. 269 (1911).

T. mayumbensis Exell in Journ Bot., LXIV, Suppl., Polypet., p. 2 (1926).

T. rosiflora De Wild. in Bull. Jard. Bot. État, Brux., V, p. 360 (1919) (non Gilg).

District du Bas-Congo : environs de Kisantu, 1903 et 1911, *Gillet.*

District du Kasaï : Lusambo, 1909, *Claessens* 167 (type) ; Benga, 1925, *Vanderyst* 14694 et 15011.

District Forestier Central : Lisala, 1910, *Bruneel ;* Mobwasa, 1914, *Vermoesen* 266 ; Nangu, 1921, *Claessens* 830 ; Angolia, 1931, *Lebrun* 2967 ; Mushie, 1932, *Lebrun* 6711 ; Boende, 1935, *L. Dubois* 748 ; Yangambi, forêt primaire de plateau, grosse liane, 1935.

Louis 225 et 540 ; id., 1936, *Louis* 2898 ; id., 1937, Louis 3771, 4016, 5566 et 6640 ; id., 1938, *Louis* 10,028.

Noms vernaculaires : Bokosaka, Bombo, Longonga lo boliki, Solo, Waolo lo boliki (dial. Turumbu, fide *Louis*) ; Ikali (dial. Lingala, fide *Vermoesen*) ; Kiziazia (dial. Kikongo, fide *Gillet*).

Observations. — 1. — Les feuilles sont obovales, arrondies ou parfois obtuses à la base, arrondies ou cuspidées au sommet. Ces caractères permettent de reconnaître l'espèce sans difficulté, d'autant plus que les feuilles sont discolores et souvent pubescentes sur les nervures à la face inférieure. Elles atteignent 15 cm. de longueur et 8 cm. de largeur. Le nombre de nervures latérales est variable ; on peut en compter de 6 à 11 sur les feuilles d'un même spécimen. Nous pensons donc que cet élément ne peut intervenir dans les diagnoses de cette espèce comme caractère transcendant. Quant aux fleurs, les sépales ont de 10 à 14 mm. de longueur et de 7 à 9 mm. de largeur ; parfois (2 cas sur 20 examinés) ils atteignent 20 mm. ; ils sont caractérisés par un revêtement interne très dense de poils soyeux assez longs. Les pétales varient entre 18 et 22 mm. de longueur.

La pilosité externe des sépales n'est pas constante ; on peut trouver toutes les gammes de variation jusqu'à l'état glabre tel qu'on le trouve normalement sur les sépales des fruits. Il n'y a donc pas lieu de conserver le *T. mayumbensis* Exell.

2. — Cette espèce se rencontre rarement en savane ; elle est commune en forêt sèche ; on la trouve au Mayombe portugais, au Bas-Congo belge et dans le District forestier central congolais.

6. — **Tetracera alnifolia** *Willd.*, Sp. pl., II, p. 1243 (1799) ; *Engl.* in Sitz. Preuss. Akad. Wiss., XXXVIII, p. 829 (1908) ; *Th.* et *Hél. Dur.*, Syll., p. 651 (1909).

T. podotricha Gilg var. *glabrescens* De Wild., Ann. Mus. Cgo, série V, I, p. 291 (1906) ; Th. et Hél. Dur., Syll., p. 16 (1909) ; De Wild., Ann. Mus. Cgo, série V, III, p. 231 (1912) ; id., Bull. Jard. Bot. État, Brux., V, p. 360 (1919) ; id., Pl. Bequaert., I, p. 151 (1921).

District du Mayombe : Vaku, 1923, *Wellens* 439.

District du Bas-Congo : Sanda, 1906, *Gillet ;* id., 1908, *Vande-*

ryst; Léopoldville, 1915, *Bequaert* 7692; Zambi, 1915, *Bequaert* 7853; Malela, 1918, *Vermoesen* 1240.

District du Kasaï: La Lulua, 1883, *Pogge* 632 (Herb. Berol.); Luluabourg, 1930, *Vanderyst* 21236, 23856, 24028, 24029 et 24092.

District Forestier Central : Lukolela, 1893, *Demeuse* 456; Eala et environs, 1903, *M. Laurent* 79 et 209; id., 1905, *M. Laurent* 1508; id., 1907, *Pynaert* 1042 et 1564; id., 1913, *Bonnivair* 39; id., 1913, *Broun;* id., 1919, *Vermoesen* 2306 et 2073; id., 1925, *Robyns* 416; id., 1930, *Lebrun* 380, 661 et 848; id., 1931, *Corbisier-Baland* 937, 1597 et 1939; id., 1936, *Coûtcaux* 54; id., 1936, *Louis* 1915; Bomana s/Giri, 1912, *Sapin;* Bokala, 1913, *Nélis;* Nouvelle-Anvers, 1913, *De Giorgi* 276, 568 et 588; île du Congo, près de Yumbi, 1913, *Bequaert* 904; Kombo sur la Ruki, 1933, *L. Dubois* 241; Basankusu, 1934, *L. Dubois* 473; environs de Bambesa, 1934, *Brédo* 1200; Bokuma, 1935, *Louis* 44.

District du Haut-Katanga : entre Pweto et Baudouinville, 1926, *Robyns* 2071.

Noms vernaculaires: Bompampassu (dial. Kundu, fide *Louis*); Bonke (dial. Kundu, fide *Corbisier*); Bonsombo (dial. Kundu, fide *Bonnivair*); Bopimpimbo na mai (dial. Kundu, fide *Coûteaux*); Bossanga (dial. Kundu, fide *Louis*); Bossombo (dial. Kundu, fide *M. Laurent*); Etondo (dial. Kundu, fide *Louis*); Gwoko-gwoko (Nouvelle-Anvers, fide *De Giorgi*); Wango ou Wengenge (dial. Kundu, fide *Robyns* et *Corbisier*); Yongo (dial. Kundu, fide *Vermoesen*).

Observations. — 1. — Cette espèce est répandue dans la zone forestière guinéenne. Si elle a été récoltée au Katanga (*Robyns* 2071), ce fut dans une galerie forestière le long d'une rivière; ce qui d'ailleurs constitue son habitat naturel.

2. — Nous considérons *T. alnifolia* et *T. podotricha* comme synonymes. Nous estimons que les différences établies par plusieurs auteurs entre ces deux espèces ne se justifient pas. Suivant Gilg [Engl., Bot. Jahrb., XXXIII, p. 200 (1902)], le seul caractère différentiel résiderait dans la glabréité ou la non-glabréité des feuilles; un tel caractère justifie à peine la distinction d'une espèce et d'une variété: c'est ce que nous avons adopté. Hutchinson [Flora of West Tropical Africa, I, p. 155 (1927)] pousse la différenciation plus loin. Il considère *T. alnifolia* comme pourvu de feuilles arron

dies au sommet, légèrement apiculées ou émarginées, glabres ou pourvues de quelques poils apprimés sur les nervures à la face inférieure ; par contre *T. podotricha* aurait des feuilles aiguës ou brusquement acuminées au sommet, largement elliptiques et le plus souvent arrondies à la base, couvertes à la face inférieure de poils longs et grêles de même que les pétioles. Après avoir examiné près de 150 spécimens, nous pouvons considérer ces différences comme irréelles ; en effet, nous avons trouvé de nombreux exemplaires avec feuilles arrondies ou acuminées sur le même plant ; d'autres avec feuilles cunéiformes ou arrondies à la base. Seule la question de la pilosité peut être retenue, mais seulement au titre de différence variétale. Hutchinson base encore la distinction des deux espèces sur les caractères des fleurs, le *T. alnifolia* aurait des pétales de 7 mm. de long ou plus, tandis que le *T. podotricha* en aurait de 4 mm. de long. L'examen du type de cette dernière espèce (Zenker 1314), montre des pétales de 6,5 mm. de long ; la différence établie n'est donc pas à retenir, d'autant plus que nous trouvons tous les degrés entre 4 mm. et 7 mm. dans les 60 fleurs examinées provenant de spécimens différents.

Enfin Exell et Mendonça [Conspectus Florae Angolensis, I, p. 7, (1937)] basent les différences sur la longueur des sépales, le *T. podotricha* les aurait longs de 4-4,5 mm., le *T. alnifolia*, de 6-7 mm. Les 60 fleurs disséquées nous montrent qu'une fleur peut avoir des sépales dont la longueur varie entre 3 et 6 mm. suivant leur position, les sépales externes étant toujours les plus courts. Il apparaît donc que le *T. podotricha* ne peut être considéré que comme une variété poilue du *T. alnifolia*.

Tetracera alnifolia var. **podotricha** *(Gilg) Stancr* comb. nov.

T. podotricha Gilg in Engl., Bot. Jahrb., XXXIII, p. 200 (1902) ; Th. et Hél. Dur., Syll., p. 16 (1909) ; De Wild., C^ie^ Kasaï, p. 354 (1910) ; id., Ét. Fl. Bangala et Ubangi, p. 350 (1911) ; id., Ann. Mus. Cgo, série V, III, p. 445 (1912) ; id., Pl. Bequaert.,I, p. 151 (1921).

District du Bas-Congo : Kisantu, 1899, *Gillet ;* Kimuenza, 1901, *Gillet* 2118 ; Lubi, 1904, *Lescrauwaet* 193 ; Luvituku, 1906, *Pynaert* 81 ; Kito, 1911, *Flamigni* 467 ; Tumba, 1913, *Verschueren* 510 ; Kamtsha, 1921, *Vanderyst* 11178 et 11185 ; Kisantu, 1930, *Vanderyst* 24644, 24659, 24660, 25183, 25190, 32677, 32866, 33696 et 39535 ; id., 1935, *Louis* 28 et 32.

District du Kasaï : Katako-Kombe, 1910, *Claessens* 377 ; Benga, 1925, *Vanderyst* 15013 et 15110 ; entre Kingundji et Popokabaka, 1925, *Vanderyst* 15251 ; Panzi, 1925, *Vanderyst* 15996 ; Kasongo-Lunda, 1925, *Vanderyst* 17561 ; Goa, 1925, *Vanderyst* 15724 ; rivière Lulua, 1883, *Pogge* 632 (Herb. Berol.) ; Mukenge, 1883, *Pogge* 632 a (Herb. Berol.).

District Forestier Central : Eala, 1905, *M. Laurent* 1507 ; Likimi, 1910, *Malchair* 303 ; Stanleyville, 1915, *Bequaert* 7034 ; Eala, 1932, *Corbisier-Baland* 1245 ; Bongandju, rive droite de l'Aruwimi, 1936, *Louis* 1325 ; Yangambi, 1938, *Louis* 8563 et 9551 ; Lukolela, *Schlechter* 12646 (Herb. Berol.).

Noms vernaculaires : Bobua (Likimi, fide *Malchair*) ; Bokosaka (dial. Turumbu, fide *Louis*) ; Kikwia ou Ngonso-ngonso (dial. Kikongo, fide *Louis*) ; Wengenge (dial. Mongo, fide *Corbisier* et *Ghesquière*).

Observation. — Au Congo, cette variété semble être surtout abondante au Bas-Congo. On la trouve dans les galeries forestières tout comme l'espèce typique, et ce dans toute l'Afrique tropicale occidentale.

7. — **Tetracera Dinklagei** *Gilg* in *Engl.*, Bot. Jahrb., XXXIII, p. 201 (1902).

T. alnifolia Willd. var. *Demeusei* De Wild. in Bull. Soc. Roy. Bot. Belg., XXXIX, p. 53 (1900).

T. Demeusei De Wild., Ann. Mus. Cgo, série V, I, p. 290 (1906) ; Th. et Hél. Dur., Syll., p. 16 (1901) ; De Wild., Ét. Fl. Bangala et Ubangi, p. 350 (1911).

District Forestier Central : Bangala, 1891, *Demeuse* 330 ; Yangambi, 1937, *Louis* 3580.

Nom vernaculaire : Bongwana (dial. Turumbu, fide *Louis*).

Observation. — Cette espèce est répandue dans la zone forestière guinéenne. Elle semble assez rare au Congo belge.

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REVISION

DES

RENONCULACÉES

DU

CONGO BELGE I[1]

PAR

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La famille des Renonculacées est représentée au Congo belge par les genres *Delphinium, Ranunculus, Thalictrum, Clematis* et *Clematopsis*. A part les espèces du genre *Clematis,* les espèces des autres genres sont confinées aux régions montagneuses de l'Est et du Sud du Congo.

Clef analytique des genres.

A. Fleurs pourvues de pétales :
  I. Fleurs pourvues d'un éperon ... ... 1. *Delphinium.*
  II. Fleurs sans éperon... ... ... 2. *Ranunculus.*

B. Fleurs dépourvues de pétales :
  I. Feuilles alternes; akènes solitaires, glabres ... 3. *Thalictrum*
  II. Feuilles opposées; akènes nombreux, densément velus:
    1. Plante lianiforme; sépales valvés ... ... 4. *Clematis.*
    2. Plante dressée; sépales imbriqués... ... ... 5. *Clematopsis.*

(1) Dans un prochain Bulletin du Jardin Botanique nous donnerons la suite de cette étude comportant la révision des espèces des genres *Clematis* et *Clematopsis.*

1. — DELPHINIUM *L.*

Clef analytique des espèces.

A. Fleurs blanches, pourvues d'un éperon de 3-4 cm. de long ... ... 1. *D. Leroyi.*

B. Fleurs bleues, pourvues d'un éperon de 0,6-0,7 cm. de long ... ... 2. *D. dasycaulon.*

Énumération des espèces.

1. — **Delphinium Leroyi** *Franch.* ex *Huth* in *Engl.*, Bot. Jahrb., XX, p. 474 (1895).

D. Gommingeri Volk. ex Engl. in Engl., Bot. Jahrb., XLV, p. 266 (1910).

District du Ruanda-Urundi : Plateau de Kihinga, près d'Usumbura, vers 1,800 m. d'alt., 1905, *Keil* (Herb. Berol.) ; Kitega, 1935, *Lejeune* 324.

Observation. — Cette espèce se rencontre au Kilimandscharo et au Ruanda-Urundi.

2. — **Delphinium dasycaulon** *Fres.* in Mus. Senckenb., II, p. 272 (1837) ; *Engl.* in *Engl.*, Bot. Jahrb., XLV, p. 269 (1910) ; *De Wild.*, Ét. Fl. Kat., I, p. 34 (1902) ; id., II, p. 37 (1913) ; *De Wild.* et *Staner*, Contrib. Fl. Kat., Suppl. IV, p. 13 (1932).

District du Haut-Katanga : Lukafu, 1900, *Verdick* 576 ; Lac Moero, 1908, *Kassner* 2823 *a* (Herb. Berol.) ; Kundelungu, 1908, *Kassner* 2748 (Herb. Berol.) ; route Pweto-Baudouinville, vers 1,400 m. d'alt., 1926, *Robyns* 2155 ; route Baudouinville vers Kasiki, 1931, *G. de Witte* 343.

Observation. — Cette espèce se rencontre en Abyssinie, au Nyassaland, au Katanga et dans les montagnes du Cameroun.

2. — RANUNCULUS *L.*

Bien que le genre *Ranunculus* soit abondamment représenté dans les régions tempérées, il n'existe pas moins de huit espèces au Congo belge, où elles sont confinées aux régions des montagnes orientales.

Il est typique de constater que parmi ces huit espèces, l'endémisme est très marqué. C'est ainsi que les *R. Ulbrichii* Engl., *R. rugegensis* Engl. et *R. vulcanicolus* Staner ne se trouvent qu'au Congo, tandis que le *R. Volkensii* Engl. n'a été récolté qu'au Congo et au Kilimandscharo et que le *R. extensus* Schube n'a été signalé qu'au Congo, au Kilimandscharo et au Cameroun. Quant aux trois autres espèces, le *R. sceleratus* L. est cosmopolite, le *R. oreophytus* croît dans les régions montagneuses de l'Afrique orientale et le *R. multifidus* Forsk. est très répandu dans toutes les régions montagneuses de l'Afrique tropicale ainsi qu'en Arabie.

La discrimination de ces espèces n'étant pas très aisée, nous nous sommes efforcé d'abstraire les caractères les plus transcendants de façon à établir une clef analytique permettant de les différencier.

Clef analytique des espèces et des variétés.

I. Feuilles non lobées:
  A. Feuilles normalement obtuses ou arrondies au sommet, entières, ondulées ou rarement dentées, atteignant souvent 30 mm. de large ... ... 1. *R. Volkensii.*
  B. Feuilles normalement aiguës au sommet, crénelées, en dents de scie ou doublement dentées, atteignant 7-15 mm. ou rarement 20 mm. de large... ... ... 2. *R. Ulbrichii.*

II. Feuilles lobées:
  A. Plantes acaules; feuilles à 3-4 paires de folioles latérales sessiles... ... ... 3. *R. oreophytus.*
    1. Feuilles de 2 à 5 cm. de long (pétiole compris); pédoncule de 0.5 à 3 cm. de long... ... ... var. *Gunae.*
    2. Feuilles de 8 à 35 cm. de long (pétiole compris); pédoncule de 3 à 8 cm. de long... ... ... var. *lanuriensis.*
  B. Plantes pourvues de tiges; feuilles à 1-2 paires de folioles latérales pétiolulées:
    1. Akènes verruqueux:
      a. Folioles ovales-lancéolées, aiguës au sommet; pétiole des feuilles basillaires de 5 à 20 cm. de long... ... ... 4. *R. multifidus.*
      b. Folioles plus ou moins subréniformes, arrondies au sommet; pétioles des feuilles ne dépassant pas 3 cm. de long ... ... 5. *R. rugegensis.*
    2. Akènes non verruqueux:
      a. Réceptacle fructifère dilaté et oblong, de 8 à 10 mm. de long... ... ... 6. *R. sceleratus.*
      b. Réceptacle fructifère de 1 à 2 mm. de long, prolongeant sans renflement le pédoncule:
        α. Fleurs blanches ... ... 7. *R. vulcanicolus.*
        β. Fleurs jaunes... ... ... 8. *R. extensus.*

Énumération des espèces et des variétés.

1. — **Ranunculus Volkensii** *Engl.*, Pflanzenw. Ostafrik., C, p. 181 (1895). (Pl. XI, fig. 1.)

District des Lacs Édouard et Kivu : Karisimbi, vers 3,100 m. d'alt., 1907, *Mildbraed* 1588 (Herb. Berol.) ; id., vers 3,800 m. d'alt., 1927, *Chapin* 334 ; id., vers 3,400 m. d'alt., 1929, *Humbert* 8572 ; id., plateau de Lukumi, vers 3,560 m. d'alt., 1932, *Lebrun* 4983 ; id., 1937, *Lebrun 7446* ; id., 1937, *Louis* 5400 ; Mikeno, vers 3,250 m. d'alt., 1926, *Linder* 2349 (Herb. Berol.) ; id., 1929, *Humbert* 8071 ; id. vers 3,200 m. d'alt., 1934, *G. de Witte* 1759.

Observation. — Cette espèce est localisée au Kilimanjaro, au Karisimbi et au Mikeno.

2. — **Ranunculus Ulbrichii** *Engl.* in *Mildbr.*, Wiss. Erg. Deutsch. Zentr.-Afr.-Exp., 1907-08, Bot., II, p. 208 (1911). (Pl. XI, fig. 2.)

District des Lacs Édouard et Kivu : montagnes à l'Ouest du Lac Kivu, près du marais Kanzibi, vers 2,200 m. d'alt., fleurs jaunes, 1929, *Humbert* 7505 ; Gahinga, vers 3,475 m. d'alt., fleurs jaunes, 1934, *G. de Witte* 1995 ; Ruwenzori, vallée de la Mabuka, 1908, *Kassner* 3137 (Herb. Brit. Mus).

District du Ruanda-Urundi : forêt du Rugege, vers 1,800 m. d'alt., 1907, *Mildbraed* 982*a* (type) (Herb. Berol.).

Observations. — 1. — Cette espèce semble localisée au Kivu, au Ruanda et au Ruwenzori.

2. — Elle se distingue à première vue du *R. Volkensii* par la forme des feuilles.

3. — **Ranunculus oreophytus** *Del.* var. **Gunae** *(Schweinf.) Ulbrich.*, l. c., p. 907 ; *De Wild.*, Pl. Bequaert., II, p. 37 (1923). (Pl. XI, fig. 3*a*.)

District des Lacs Édouard et Kivu : Ruwenzori-Butagu, vers 3,800-4,000 m. d'alt., 1914, *Bequaert* 3859 ; id., vers 4,000-4,400 m. d'alt., 1929, *Humbert* 8922 ; id., vallée de la Kiterere, vers 3,800 m. d'alt., 1931, *Lebrun* 4549 ; Karisimbi, vers 3,800 m. d'alt., 1929, *Scaetta* 1602.

Ranunculus oreophytus *Del.* var. **lanuriensis** *De Wild.* in Pl. Bequaert., II, p. 39 (1923). (Pl. XI, fig. 3*b*.)

R. oreophytus Del. var. *genuinus* Ulbrich in Notizbl. Bot. Gart. Berlin, X, p. 906 (1930).

District des Lacs Édouard et Kivu : Ruwenzori-Butagu, 1908, *Mildbraed* 2584 (Herb. Berol.) ; id., vers 3,800-4,000 m. d'alt., 1914, *Bequaert* 3859bis ; id., Lanuri vers 3,500 m. d'alt., 1914, *Bequaert* 4503 (type) ; Karisimbi, vers 3,800 m. d'alt., 1927, *Chapin* 331 ; id., vers 3,560 m. d'alt., 1932, *Lebrun* 4977 ; id., vers 4,100 m. d'alt., 1932, *Lebrun* 4986 ; selle de Kabara, entre le Karisimbi et le Mikeno, vers 3,000-3,100 m. d'alt., 1937, *Lebrun* 7353 ; id., 1937, *Louis* 5309 ; Mikeno, vers 3,250 m. d'alt., 1929, *Humbert* 8061 ; id., 1929, *Scaetta* 1585 ; id., vers 3,200 m. d'alt., 1934, *G. de Witte* 1760 ; Muhavura, vers 4,100 m. d'alt., 1907, *Mildbraed* 1838 (Herb. Berol.).

Observations. — Ces deux variétés sont des formes écologiques facilement reconnaissables l'une de l'autre. Elles se retrouvent toutes deux dans les régions afro-alpines de l'Afrique tropicale orientale.

4. — **Ranunculus multifidus** *Forsk.*, Fl. Aegypt. Arab., p. 102 (1775). (Pl. XI, fig. 4).

R. pubescens Thbg., Prodr., Fl. Cap., II, p. 94 (1800) ; De Wild., Pl. Bequaert., II, p. 40 (1923) ; De Wild., Contrib. Fl. Kat., p. 61 (1921).

R. pinnatus Poir. in Lam., Encycl., VI, p. 126 (1804).

R. Forskahlii DC. in Reg. Veg. Syst. Nat., I, p. 303 (1818).

R. membranaceus Fres. in Mus. Senckenb., II, p. 270 (1837).

District du Lac Albert : Vallée du Shari, 1921, *Claessens* 1354.

District des Lacs Édouard et Kivu : Ruwenzori, vallée de la Butagu, vers 2,300 m. d'alt., fleurs jaunes, 1914, *Bequaert* 3680 ; id., vallée de la Lanuri, vers 3,000 m. d'alt., fleurs jaunes, 1914, *Bequaert* 2978 ; Beni, 1938, *Gille* 107 ; entre Beni et Lubero, vers 1,500 m. d'alt., fleurs jaunes, 1931, *Lebrun* 4268 et 4290 ; entre Kasindi et Lubango, vers 1,800 m. d'alt., fleurs jaunes, 1931, *Lebrun* 4783 ; entre Lubero et Luofu, 1925, *Claessens ;* Wimbi-Lubero, vers 2,200 m. d'alt., fleurs jaunes, *Louis* 4653 ; lac Kalago, près du Karisimbi, vers 2,300 m. d'alt., 1907, *Mildbraed* 1539 (Herb. Berol.) ; marais du cratère Tshikerere, à la base sud du Mikeno, vers 2,200 m. d'alt., 1929, *Humbert* 8056ter ; Mikeno, vers 3,000 m. d'alt., 1930, *B. D. Burtt* 3023 ; id., vers 3,200 m. d'alt., fleurs jaunes, 1934, *G. de Witte* 1697 ; Karisimbi, vers 3,140 m.

d'alt., 1929, *Humbert* 8613ter ; id., vers 3,700 m. d'alt., fleurs jaunes, 1937, *Lebrun* 7451 ; Nyamuragira, vers 1,900 m. d'alt., fleurs jaunes, 1937, *Louis* 5129 ; Mikeno, vers 2,175 m. d'alt., fleurs jaunes, 1937, *Louis* 5142 ; Karisimbi, vers 3,650 m. d'alt., fleurs jaunes, 1937, *Louis* 5405 ; Kamatembe, 1934, *G. de Witte* 1554 ; lac Gando, vers 2,350 m. d'alt., fleurs jaunes, 1935, *G. de Witte* 2301 ; lac Mogera, fleurs jaunes, 1934, *G. de Witte* 1429 ; Mukule, steppe à Acanthus, fleurs jaunes, 1914, *Bequaert* 5900 ; Kibati, fleurs jaunes, 1934, *G. de Witte* 1256 ; île Idjwi, 1929, *Scaetta* 939 ; montagnes à l'Ouest du Lac Kivu, marais Kanzibi, vers 2,200 m. d'alt., 1929, *Humbert* 7553 ; Tshibinda, 1929, *Scaetta* 94 M, 1225 et 1234 ; Katana, vers 1,400 m. d'alt., 1933, *De Wulf* 4 ; lac Mokoto, entre Tshungu et Mohanga, vers 1,400 m. d'alt., 1937, *Ghesquière* 4983 ; vallée de la Ruzizi, 1937, *Rossignol* 17.

District du Ruanda-Urundi : lac Mohasi, vers 1,550 m. d'alt., 1907, *Mildbraed* 656 (Herb. Berol.) ; Rushaki-Biumba, vers 1,900 m. d'alt., 1932, *Becquet* 205 ; Astrida, vers 1,600 m. d'alt., 1933, *Becquet* 724.

District du Haut-Katanga : Élisabethville, *Rogers* (Herb. Brit. Mus.) ; Yembe-Yembe, 1911, *Hock ;* Pweto, vers 1,350 m. d'alt., 1926, *Robyns* 2163 ; Élisabethville, 1934, *Quarré* 4289.

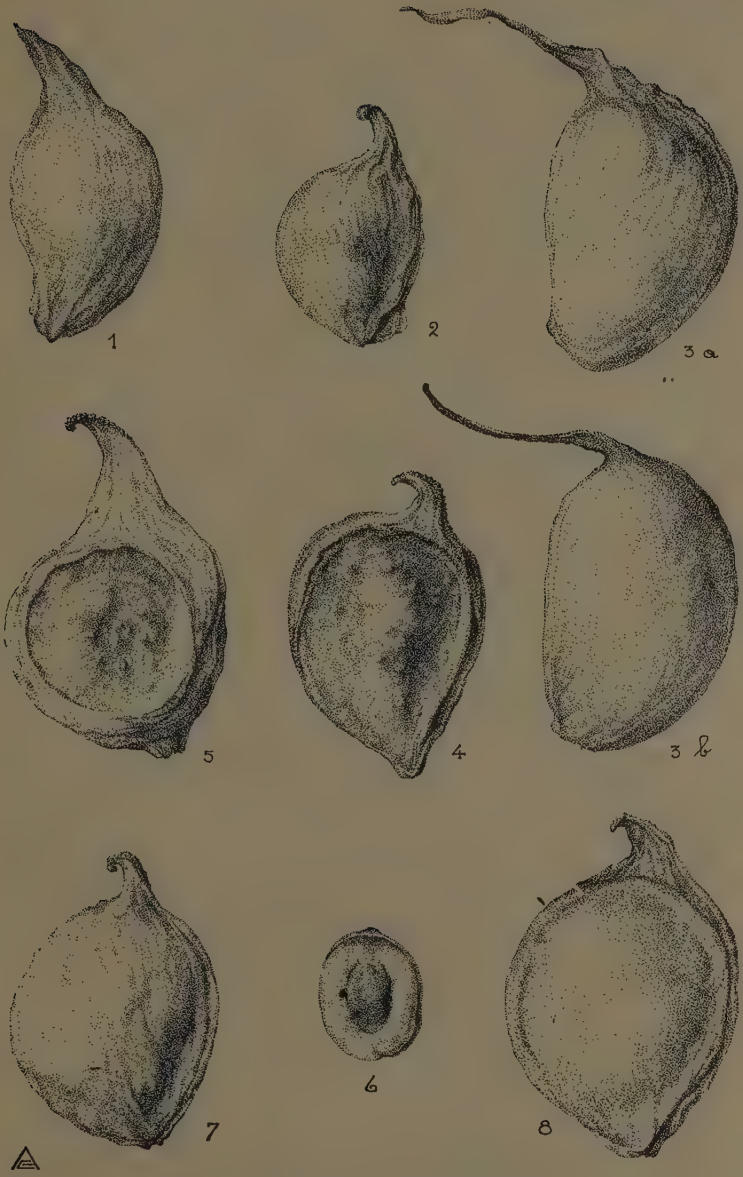
Observation. — Cette espèce a été signalée la première fois par Forskal (l. c.) en Arabie méridionale dans la région de Tais, à 75 km. à l'Est de la côte de la Mer Rouge. Depuis lors, on l'a surtout rencontrée en Afrique dans toute la région montagneuse orientale, depuis l'Abyssinie jusqu'au Cap, ainsi que dans les montagnes du Cameroun et de Fernando-Po.

5. — **Ranunculus rugegensis** *Engl.* in *Mildbr.*, Wiss. Erg. Deutsch. Zentr.-Afr.-Exp., 1907-08, Bot. II, p. 208 (1911). (Pl. XI, fig. 5.)

District du Ruanda-Urundi : forêt du Rugege, 1,800 m. d'alt., 1907, *Mildbraed* 945 (Herb. Berol.) (type).

Observations. — 1. — Cette espèce n'a été signalée qu'au Ruanda.

2. — Elle se caractérise par des feuilles très courtement pétiolées par rapport aux autres espèces du genre, ainsi que par des folioles arrondies à dents obtuses. Au premier abord, cette plante rappelle les *Afrardisiandra*.



Akènes des *Ranunculus* du Congo Belge (× 15).
1. *R. Volkensii.* — 2. *R. Ulbrichii.* — 3 a. *R. oreophytus* var. *Gunae*; 3 b. *R. oreophytus* var. *lanuriensis.* — 4. *R. multifidus.* — 5. *R. rugegensis.* — 6. *R. sceleratus.* — 7. *R. vulcanicolus.* — 8. *R. extensus.*

6. — **Ranunculus sceleratus** *L.*, Sp. Pl., I, p. 551 (1753) (Pl. XI, fig. 6).

District des Lacs Édouard et Kivu : près du Karisimbi, vers 2.300 m. d'alt., 1907, *Mildbraed* 1548 (Herb. Berol.) ; Kamatembe, fleurs jaunes, 1934, *G. de Witte* 1559.

Observation. — Cette espèce, bien que cosmopolite, est nettement localisée au Congo.

7. — **Ranunculus vulcanicolus** *Staner* nov. sp. ; ab affini *R. aberdarico* Ulbrich, foliolis terminalibus ovalibus, foliolis lateralibus petiolulatis, floribus homomorphis distincta (Pl. XI, fig. 7).

Herba perennis radicibus fibrosis valde ramosis fuscidis subcarnosis foliis radicalibus subrosulatis longe petiolatis, caule repente stolonifero ad 10-20 cm. et ultra longo, rhizoma 2-5 cm. longa. *Caulis* glaber vel ad nodos parce villosus. *Folia* ternata petiolo parce villoso vel (foliorum radicalium) inferiore parte glabro, ima basi vagina ad 60 mm. longa ab utraque parte 2-4 mm. lata membranacea fuscidula munito, ad laminae basin 10-50 cm. (in foliis radicalibus) vel 2-20 cm. (in foliis caulinis) longo ; laminae partes terminales petiolulo 5-40 mm. instructae, circuitu ovatae, basin versus acuto-vel obtuso-cuneatae, inaequilater trilobae apice 3 fidae, 20-60 mm. longae et 30-50 mm. latae ; laminae partes laterales petiolulo 2.5-5 mm. longo, instructae, circuitu oblique ovatae, basin versus plus minusve truncatae, inaequilater trilobae apice 3-fidae, 20-50 mm. longae et 30-50 mm. latae ; lamina in sicco fuscido-viridis utrinque plus minusve pilosa, margine fimbriata, dentibus acutis. *Flores* ad ramorum apicem dispositi, *albidi* pedunculo 5-30 mm. longo villoso recto instructi ; sepala 5 fuscido-viridis, oblonga, plus minusve conchiformis, 5-7 mm. longa et 2-2.5 mm. lata, glabra ; petala 5 oblonga-obovata, basin versus cuneata, apice rotundata, 7-10 mm. longa et 3-4 mm. lata, in sicco fuscidula nervis imprimis extrinsecus distinctis fuscidulis intus paulo indistinctioribus parce dichotomis perductis ; stamina 2-4 mm. longa filamentis taeniatis glabris anthera ovoidea vix 1 mm. longa ; ovaria subsessilia glabra ovoidea, plus minusve 2 mm. longa compressa in stylum hamosum abrupte contracta. *Fructus* ovoideus 2-3 mm. longus et plus minusve 2-2.5 mm. latus, compressus glaber, laevis margine carinatus, apice stylo brevissimo hamoso coronatus.

District des Lacs Édouard et Kivu : Kabara, entre le Mikeno et le Karissimbi, vers 3,200 m. d'alt., fleurs à pétales blancs, étamines jaunes, carpelles verts, juin 1927, *Chapin* 339 ; Mikeno, vers 3,250 m. d'alt., avril 1929, *Humbert* 8056bis ; Karisimbi, 1929, *Scaetta* 1597 ; Karisimbi, plateau de Lukumi, vers 3,560 m. d'alt., alpages, herbe vivace, plus ou moins couchée sur le sol, fleurs blanches, février 1932, *Lebrun* 4978 ; Kabara, Mikeno, vers 3,200 m. d'alt., prairie marécageuse, fleurs blanches, juillet 1934, *G. de Witte* 1756 ; Kabara, selle située entre le Karisimbi et le Mikeno, vers 3,000-3,100 m. d'alt., clairière herbeuse dans l'étage des Hagenia, souche verticale, fleurs blanches, août 1937, *Lebrun* 7365 ; id., herbe rhizomateuse dressée, de 20-60 cm. de haut, formant un tapis dense avec les Ombellifères, fleurs blanches à corolle finement membraneuse, août 1937, *Louis* 5276 (type) ; id., clairière herbeuse à tendance subalpine dans l'étage des Hagenia, station parsemée de blocs basaltiques, herbe vivace à souche verticale, fleurs blanches, août 1937, *Louis* 5320.

Observations. — 1. — Cette espèce semble voisine du *R. aberdaricus* Mildbr. ; elle s'en différencie cependant par la forme générale de la foliole supérieure et par l'attache des folioles latérales. L'examen des quelques cinquante exemplaires que nous possédions ne nous a pas révélé l'existence de fleurs cleistogames qui paraissent caractériser le *R. aberdaricus*.

2. — La localisation du *R. vulcanicolus* à la selle de Kabara située entre les volcans Mikeno et Karisimbi et aux environs immédiats, nous a particulièrement incité à créer cette espèce nouvelle. Il n'est guère possible que la seule Renoncule à fleurs blanches du Congo ait échappé aux investigations des naturalistes en dehors de l'endroit où elle fut récoltée. Il semble donc bien que l'endémisme de cette espèce soit réel, élément qui justifierait à lui seul l'apellation nouvelle.

8. — **Ranunculus extensus** *(Hook f.) Schubc* in *Engl.* Hochgebirgsfl. d. trop. Afr., p. 218 (1892). (Pl. XI, fig. 8.)

R. pinnatus Poir. var. *extensa* Hook. f. in Journ. Linn. Soc., VI, p. 5 (1862).

R. Bequaerti De Wild. in Pl. Bequaert., II, p. 35 (1923).

R. Bequaerti var. *minor* De Wild., l. c., p. 36.

District des Lacs Édouard et Kivu : Ruwenzori, vallée de la Butagu, vers 2,000 m. d'alt., fleurs jaunes, 1914, *Bequaert* 3575 ;

id., Kalongi, vers 2,300 m. d'alt., fleurs jaunes, 1927, *Chapin* 187 ; id., vallée de la Lume, vers 2,000 m. d'alt., 1929, *Humbert* 8967bis ; vallée de la Muboka, vers 1,760 m. d'alt., fleurs jaunes, 1931, *Lebrun* 4425 ; Niragongo, vers 2,800 m. d'alt., 1907, *Mildbraed* 1330 (Herb. Berol.) ; Mikeno, vers 2,800 m. d'alt., fleurs jaunes, 1927, *Chapin* 419 ; Mushumangabo, à l'Est du Nyamuragira, vers 1,900 m. d'alt., fleurs jaunes, 1937, *Louis* 5129bis ; marais du cratère Tshikerere à la base sud du Mikeno, vers 2,200 m. d'alt., 1929, *Humbert* 8056 ; Mukule, steppe à Acanthus, fleurs jaunes, 1914, *Bequaert* 5894 ; environs de Katana, vers 2,200 m. d'alt., 1932, *Vanden Hout* 453.

Observations. — 1. — Cette espèce ne peut être confondue avec le *R. multifidus* Forsk. lequel lui ressemble à première vue. Il suffit de comparer les akènes et les feuilles. Les akènes du *R. extensus* (Hook. f.) Schube sont dépourvus de rugosités tandis que les feuilles sont trifoliolées et à folioles dyssymétriquement lobées.

2. — Le *R. extensus* existe dans les régions montagneuses du Cameroun et de Fernando Po ainsi qu'au Kilimandjaro et dans la région du Ruwenzori et des volcans du Congo.

3. — THALICTRUM *L.*

Thalictrum rhynchocarpum *Dillon* et *Rich.* in Ann. Sc. Nat., XVI, p. 262 (1840) ; *Th.* et *Hél. Dur.*, Syll. Fl. Congol., p. 15 (1909) ; *De Wild.*, Pl. Bequaert., II, p. 40 (1923) ; *Weimarck* in Sv. Bot. Tids., XXX, pp. 46-56 (1930).

District des Lacs Édouard et Kivu : Virunga, vers 2,500 m. d'alt., 1894, *Goetzen* 60 (Herb. Berol.) ; Kissenye, vers 2,200 m. d'alt., 1907, *Mildbraed* 1307 (Herb. Berol.), volcan Niragongo, 1911, *Fries* 1637 (Herb. Upps.) ; Ruwenzori, vallée de la Butagu, 1,600-1,800 m. d'alt., 1914, *Bequaert* 3557 ; Mukule, 1914, *Bequaert* 5892 ; Djugu, forêt, 1921, *Claessens* 1406 ; Lulenga, 1927, *Vanden Houdt* 91 ; volcan Karisimbi, 2,900 m. d'alt., 1927, *Chapin* 386 ; vallée de la Ruzizi, Mts Lemera, 2,900 m. d'alt., 1927, *Chapin* 518 ; volcan Niragongo, 2,600 m. d'alt., 1927, *Linder* 2116 ; entre Mutumoya et N'dolo, 1928, *Scaetta* 313 ; Mwendula, 1,850 m. d'alt., forêt, 1928, *Scaetta* 750 et 752 ; de Moshati à Karoba, entre 1,600 et 1,900 m. d'alt., 1928, *Scaetta* 832 ; forêt à l'Ouest de Tshibinda, vers 2,000 m. d'alt., 1929, *Humbert* 7448 ; volcan Sabinio, 2,500 m.

d'alt., 1930, *B. D. Burtt* 2973 (Herb. Kew.) ; forêt de Djugu, vers 1,800 m. d'alt., 1931, *Lebrun* 3896 ; Ruwenzori, vallée de la Muboka, vers 1,800 m. d'alt., forêt, 1931, *Lebrun* 4416 ; entre Kasindi et Lubango, vers 1,800 m. d'alt., rivière, 1931, *Lebrun* 4731 ; à l'Ouest de Katana, vers 2,000 m. d'alt., 1932, *Vanden Houdt* 323 et 433 ; forêt de Djugu, 1932, *Lathouwers* I. 62 ; Burungo, forêt, 1934, *G. de Witte* 1476 ; Kamatembe, 1934, *G. de Witte* 1607 ; Salingo-Gahinga, vers 2,600 m. d'alt., forêt de bambous, 1934, *G. de Witte* 1964 ; environs de Beni, 1937, *Gille* 43 ; M^t^ Dia, près de Bunia, forêt, 1937, *Gilbert* 538 ; Kiniasi-Kahundu, 1937, *Ghesquière* 4842 ; entre Busayo et Kibati, forêt, vers 1,900 m. d'alt., 1937, *Lebrun* 8683 ; M^ts^ Virunga, 2,500 m. d'alt., *Eggeling* 1038 (Herb. Kew.).

District du Ruanda-Urundi : Ruhengeri, vers 1,800 m. d'alt., jachères, 1933, *Becquet* 193 ; Rutare-Biumba, vers 1,800 m. d'alt., 1933, *Becquet* 656 ; Rugege, forêt, 1907, *Mildbraed* 757 (Herb. Berol.).

Observation. — Cette espèce est répandue dans toute la région montagneuse de l'Afrique tropicale orientale, depuis l'Abyssinie jusqu'au Cap, ainsi que dans les montagnes du Cameroun et de Fernando-Po. Elle ne descend pas au-dessous de 1,500 m. d'altitude.

Jardin Botanique de l'Etat, Bruxelles.

SUR LA RÉPARTITION

DU

GENRE

BATRACHOSPERMUM

EN

BELGIQUE

PAR

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Introduction.

La distribution du genre *Batrachospermum* en Belgique est mal connue. Peu de botanistes se sont, en effet, occupés de cette algue.

La Flore (1) et le Prodrome (2) de De Wildeman renferment toutes les connaissances à ce sujet jusqu'en 1898 ; ces travaux renseignent beaucoup de nouvelles stations et apportent des corrections heureuses aux déterminations des anciens herborisateurs (l'auteur a notamment rapporté certaines espèces et variétés au type *B. moniliforme* Roth.).

Depuis lors, l'étude du genre semble avoir été abandonnée.

(1) De Wildeman, E., *Flore des Algues de Belgique*, pp. 404-408, Bruxelles (1896).

(2) De Wildeman, E. et Durand, Th., *Prodrome de la Flore belge*, I, pp. 181-182, Bruxelles (1898).

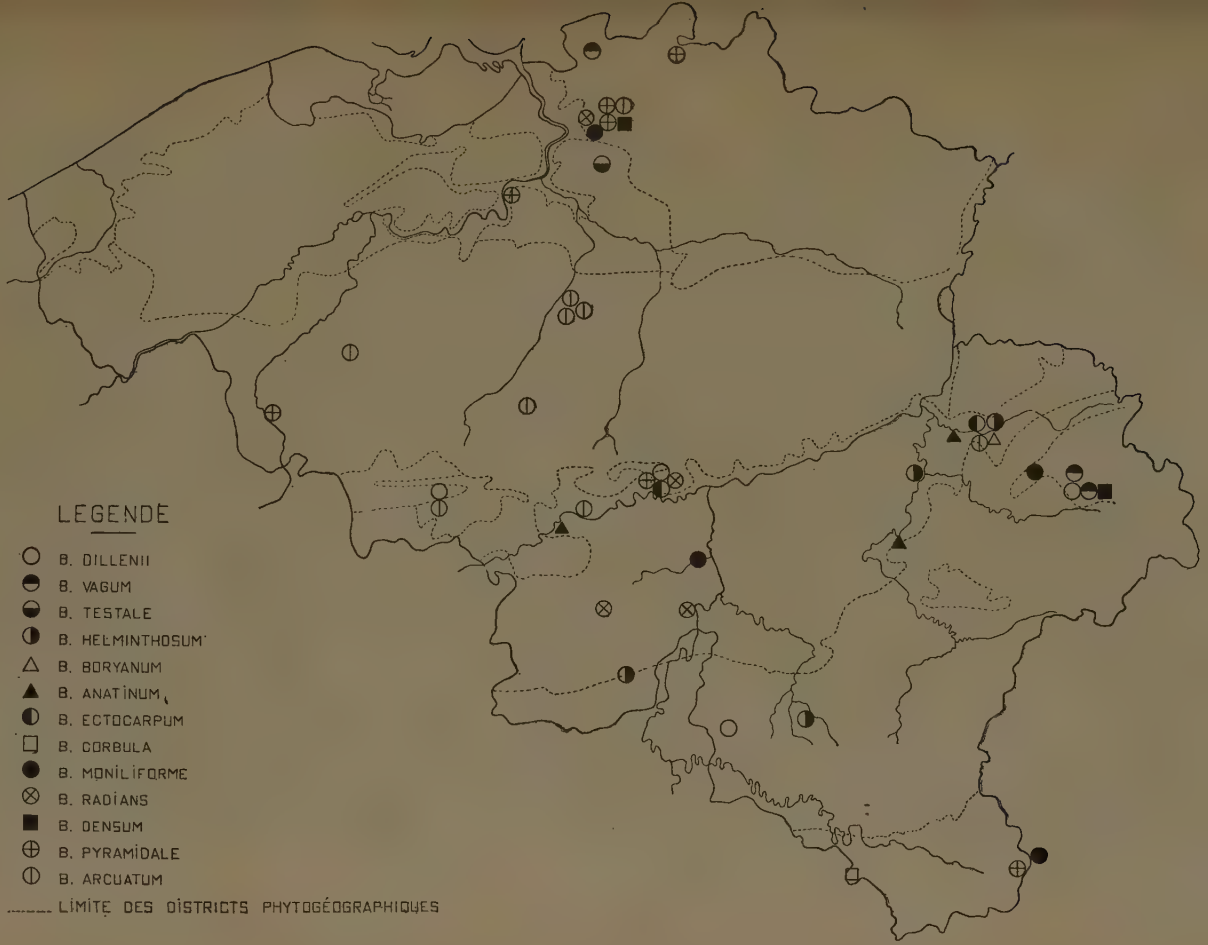
La découverte de plusieurs nouvelles stations pour la flore des districts Poldérien et Campinien des environs d'Anvers, au cours de nos herborisations de ces cinq dernières années, nous a suggéré l'idée de revoir les espèces indigènes de façon à en esquisser la distribution dans le pays.

Cette étude nous a permis de découvrir 4 espèces nouvelles pour la flore belge : *B. testale, B. ectocarpum, B. corbula* et *B. radians*. Afin de permettre une comparaison avec le Prodrome, nous avons réparti les espèces par provinces et par stations (voir tableau, fig. 44). Comme on le voit, ce sont les espèces *B. arcuatum. B. pyramidale* et *B. moniliforme* qui ont la dispersion la plus vaste.

Toutefois, il est impossible de dire en ce moment si une espèce reste localisée dans un district phytogéographique déterminé : trop peu d'herborisations ont été faites en ce sens et ce n'est que dans quelques années que l'on pourra vraiment se faire une idée à ce sujet.

ESPÈCES	Flandre occidentale	Flandre orientale	Anvers	Limbourg	Brabant	Namur	Liége	Hainaut	Luxembourg	Total
B. *Dillenii*	—	—	—	—	—	2	1	1	—	4
B. *vagum*	—	—	1	—	—	—	2	—	—	3
*B. *testale*	—	—	1	—	—	—	—	—	—	1
B. *helminthosum* . . .	—	—	—	—	—	1	2	—	1	4
B. *Boryanum*.	—	—	—	—	—	—	1	—	—	1
B. *anatinum*	—	—	—	—	—	—	1	1	1	3
*B. *ectocarpum*	—	—	—	—	—	1	1	—	—	2
*B. *corbula*.	—	—	—	—	—	—	—	—	1	1
B. *moniliforme*	—	—	1	—	—	1	1	—	1	4
*B. *radians*	—	—	1	—	—	3	—	—	—	4
B. *densum*.	—	—	1	—	—	—	1	—	—	2
B. *pyramidale*	—	—	4	—	—	1	—	1	1	7
B. *arcuatum*	—	1	1	—	4	—	1	2	—	9

Fig. 44. — Répartition par provinces des espèces de *Batrachospermum* connues actuellement en Belgique. Les chiffres indiquent le nombre de stations. Les noms précédés de * sont des espèces nouvelles pour la Belgique.



Répartition des espèces de *Batrachospermum* en Belgique.

Nous nous sommes néanmoins efforcé de porter les stations sur une carte (voir Planche XII), tout en nous rendant très bien compte de l'inefficacité d'un tel système : beaucoup d'indications trop générales que l'on rencontre fréquemment dans certains herbiers s'opposent à l'établissement d'une carte rigoureusement exacte.

En ce qui concerne la distribution générale, on peut remarquer, sur notre carte, que *B. pyramidale* est commun à tous les districts phytogéographiques, sauf en Ardennes ; que *B. corbula* n'est connu jusqu'ici avec certitude que dans le Jurassique ; que *B. ectocarpum*, *B. anatinum* et *B. Boryanum* restent jusqu'à présent cantonnés dans le District calcaire. *B. helminthosum* existe dans le Calcaire et les Ardennes ; *B. radians* et *B. densum* ne se rencontrent que dans les Districts calcaire et Campinien ; *B. vagum* dans le milieu acidophile des Sphaignes et dans les régions tourbeuses, en Campine et dans les Fagnes. Enfin, *B. testale* n'a été indiqué que dans le District Campinien.

Nous nous sommes servi en premier lieu du matériel conservé dans l'Herbier général du Jardin Botanique de l'État à Bruxelles, ainsi que des notes y laissées par le Dr. H. Skuja, dont ce dernier a bien voulu nous permettre de faire usage. Nous avons consulté également l'Herbier de l'Université de Liége (Institut de Botanique) où nous avons trouvé des documents particulièrement intéressants.

Il est regrettable, toutefois, de devoir constater que beaucoup de matériaux demeurent inutilisables par manque d'indications géographiques. Dans le but d'éviter des erreurs et des remaniements toujours pénibles, nous n'avons pas tenu compte, momentanément, des stations mentionnées dans la littérature dont nous n'avons pu vérifier les échantillons originaux.

Nous sommes décidé d'ailleurs à continuer nos recherches dans les herbiers publics et privés et nous nous permettons de faire ici un appel à tous nos confrères et correspondants pour nous communiquer le plus possible de matériaux et de renseignements.

Le genre *Batrachospermum* semble être plus répandu dans notre pays que l'on ne se l'imaginait il y a quelques années et les herborisations que nous avons pu faire jusqu'ici nous ont fait prévoir que nous sommes encore loin de connaître toutes les richesses que la Belgique nous réserve à ce sujet. Une fois de plus l'on se rend

très bien compte de l'exactitude des paroles de Kufferath (1) : « Nous sommes encore loin de connaître la Flore algologique de notre pays aussi bien que les phanérogames ; plusieurs provinces ont été délaissées, de même que des familles entières d'algues et une étude approfondie de leur flore nous réserve encore beaucoup de trouvailles. »

Si nous ne savons presque rien au sujet de la distribution géographique du genre étudié, nous ignorons complètement l'influence des facteurs écologiques sur cette distribution, de même que son importance au point de vue phytosociologique. Afin donc de rassembler le plus de facteurs pouvant aider éventuellement une mise au point, nous nous sommes efforcé de décrire les milieux le plus fidèlement possible. Toutefois, les matériaux envoyés par nos correspondants ne feront-ils provisoirement l'objet que d'une simple indication géographique.

Nous avons récolté des espèces aussi bien dans les formations stagnales, quoique plus rarement, que dans l'eau courante, seules ou au milieu d'associations diverses : trois fois nous en avons observé en association étroite avec *Chaetophora incrassata* (Huds.) Hazen, notamment : *B. arcuatum* à 's Gravenwezel, *B. pyramidale* à Hoogstraten et *B. radians* à Onoz. A Weert, en plein district poldérien, nous avons observé *B. pyramidale* en association avec *Oedogonium* sp. (stérile). Dans presque tous les autres cas l'espèce était solitaire, attachée aux pierres, à des tiges de plantes aquatiques ou à des ouvrages d'art en bois.

Afin de permettre des recherches ultérieures, nous avons indiqué le lieu de conservation des échantillons originaux : (Br.) : Jard. Bot. État Brux. ; (Lg.) : Instit. Bot. Univ. Liége ; (V. M.) : Herbier Van Meel, Anvers.

En terminant, nous tenons à remercier tous ceux qui nous ont aidé à réaliser ce travail : le Prof. Dr. W. Robyns, Directeur du Jardin Botanique de l'État à Bruxelles, et le Dr. P. Staner, Conservateur de l'Herbier, qui ont largement facilité nos recherches ; le Prof. Dr. Ray. Bouillenne, Directeur de l'Institut de Botanique de l'Université de Liége, qui a bien voulu nous confier les matériaux conservés dans l'Herbier de l'Institut ; le Dr. H. Skuja, Assistant à l'Institut de Botanique de l'Université à Riga (Lettonie), qui a bien voulu revoir les échantillons recueillis par nous, et enfin tous

(1) Kufferath, H., Court aperçu sur l'histoire de l'Algologie en Belgique pendant un siècle, in *Bull. Nat. Belges*, pp. 15-16 (1931).

nos nombreux correspondants et amis : MM. Bennaerts (Anvers), Dr. Culot (Montignies s/Sambre), Demaret (Bruxelles), Gregorius (Arlon), P. Heinemann (Bruxelles), E. Hostie (Anvers), H. Kufferath (Bruxelles), Panneels (Bruxelles), qui nous ont envoyé des matériaux particulièrement intéressants. Que tous reçoivent ici l'expression de notre gratitude.

Énumération des espèces.

1. — **Batrachospermum Dillenii** *Bory* in Dict. Class. Hist. Nat., II, Paris (1822-1831), p. 226 ; *De Toni,* Syll. Alg., IV, p. 57 (1897) ; *Hamel,* Rev. Algol., II, 3-4, p. 290 (1925) ; *Pascher,* Sussw.-Flora, XI, p. 175 (1925) ; *De Wild.,* Fl. Alg. Belg., Brux., p. 407 (1896) ; *De Wild.,* Prodr. Fl. Belg., Brux., p. 182 (1898-1907).

Icones : *Sirod.,* Batrachospermes, pl. 20-21-22 (1884).

Exsiccata : *Van Meel,* Algae Belgicae Exsiccatae, Dec. 1, N° 4 (1939).

Synonymes : *Batrachospermum tenuissimum* Bory in Westendorp, Herb. Cryptog Belge, N° 1098 (1851).

Localités : Malmédy, les Piesses, ruisseau de la Cartonnerie, 1822, *Lejeune,* (Br.) ; Malmédy, ruisseau du Moulin à tan de Marlyr, dans la Warche, près de la Cartonnerie, *M. A. Libert,* (Br.) ; Mons, 1854, *Tosquinet,* (Br.) ; Mons, fontaine de Saulchoir, *Marissal,* (Br.) ; Louette St-Pierre, *Gravet,* (Br.) ; Onoz-Spy, 1938, *Van Meel,* (V. M.).

Observation. — La station que nous signalons à Onoz-Spy est une petite source assez profonde entre de grandes pierres, près du tunnel du chemin de fer. Le fond est tapissé de *Fontinalis sp.* Le *B. Dillenii* occupe les parois latérales les plus obscures. Eau à pH = 7.5.

2. — **Batrachospermum vagum** *(Roth) Ag.* in Syst. Alg., p. 52 (1824) ; *De Toni,* loc. cit., p. 58 ; *Hamel,* loc. cit., p. 291 ; *Pascher,* loc. cit., p. 190 ; *De Wild.,* Fl. Alg. Belg., Brux., p. 407 (1896) ; *De Wild.,* Prodr. Fl. Belge, Brux., p. 182 (1898-1907).

Synonymes : *B. vagum* var. *keratophytum* De Wild. in Fl. Alg. Belg., p. 407 (1896) (non Sirod).

Icones : *Sirod,* loc. cit., pl. 34-35-36-37-38-39 ; *Pascher,* loc. cit., p. 188-189-191, fig. 53-54-55-56.

Localités : Malmédy, tourbières, *M. A. Libert,* (Br.) ; Calmpthout, Nolsven, 1886, *De Wildeman,* (Br.) ; Hockay, 1893, *De Wildeman,* (Br.).

3. — **Batrachospermum testale** *Sirod,* loc. cit., p. 244 ; *De Toni,* loc. cit., p. 62 ; *Hamel,* loc. cit., p. 290.

Icones : *Sirod.,* loc. cit., pl. 42-43 ; *Pascher,* loc. cit., p. 193, fig. 61-62-63.

Localités : Wijneghem, Klein Schijn ruiss., 1937, *Van Meel* (V. M.).

4. — **Batrachospermum helminthosum** Sirod., loc. cit., p. 240 ; *De Toni,* loc. cit., p. 55 ; *Hamel,* loc. cit., p. 237 ; *Pascher,* loc. cit., p. 184.

Synonymes : *B. moniliforme* var. *scopula* Douret in De Wild., Fl. Alg. Belg., p. 406, 1896 ; (non Roth).

Icones : *Sirod.,* loc. cit., pl. 26-27-28 ; *Pascher,* loc. cit., fig. 41-42-43.

Localités : Villance, dans la Lesse, 1885, *A. Douret,* (Br.) ; Olloy, ruisseau des Nouées, 1882, *C. Aigret,* (Br.) ; Géromont, *M. A. Libert,* (Br.) ; Nessonvaux, pierres dans les eaux pures, *Courtois,* (Lg.).

5. — **Batrachospermum Boryanum** *Sirod.,* loc. cit., p. 246 ; *De Toni,* loc. cit., p. 56 ; *Hamel,* loc. cit., p. 298 ; *Pascher,* loc. cit., p. 186 ; *De Wild.,* Fl. Alg. Belg., p. 406 (1896) ; *De Wild.,* Prodr. Fl. Belg., p. 181 (1898-1907).

Icones : *Sirod.,* loc. cit., pl. 19-30-31 ; *Pascher,* loc. cit., p. 186-187, fig. 46-47-48.

Localités : Nessonvaux, 1821, *Lejeune* (Br.).

6. — **Batrachospermum anatinum** *Sirod.,* loc. cit., p. 249 ; *De Toni,* loc. cit., p. 57 ; *Hamel,* loc. cit., p. 298 ; *Pascher,* loc. cit., p. 186 (1925).

Icones : *Sirod.*, loc. cit., pl. 32-33 ; *Pascher,* loc. cit., pp. 187-188, fig. 49-52.

Localités : Montignies-le-Tilleul, 1930, *Dr. Culot,* (V. M.) ; Barvaux, dans l'Ourthe, 1937, *E. Hostie,* (V. M.) ; Chaudfontaine, fontaine de Ninane, 1829, (Lg.).

7. — **Batrachospermum ectocarpum** *Sirod.*, loc. cit., p. 222 ; *De Tony,* loc. cit., p. 54 ; *Hamel,* loc. cit., p. 300 ; *Pascher,* loc. cit., p. 184.

Icones : *Sirod.*, loc. cit., pl. 7-8 ; *Pascher,* loc. cit., pp. 181-182, fig. 37-38-39.

Exsiccata : *Van Meel,* Algae Belgicae Exsiccatae, Dec. 1, N° 1 (1939).

Localités : Nessonvaux, dans la Vesdre, 1936, *Van Meel* (V.M.) ; Onoz-Spy, fontaine de Maintenon, 1938, *Van Meel* (V. M.).

Observation. — La fontaine de Maintenon, située sur le Domaine de Mielmont à Onoz-Spy, s'écoule entre deux murs d'environ 2 m. de hauts couverts d'une végétation abondante de Mousses et d'Hépatiques. Le *B. ectocarpum* y croît abondamment, attaché aux pierres disséminées dans une eau fraîche et ombragée. Eau à pH = 7.7.

8. — **Batrachospermum corbula** *Sirod.*, loc. cit., p. 226 ; *Hamel,* loc. cit., p. 300 ; *De Toni,* loc. cit., p. 54.

Icones : *Sirod.*, loc. cit., pl. 5-6.

Localités : Orval, fontaine Mathilde, 1937, *Demaret* (Br.) (V. M.).

Observation. — M. F. Demaret (1) décrit cette station comme suit : eau claire et glacée contenant, complètement submergés : *Chiloscyphus polyanthus* (L.) Corda var. *rivularis* Loeske et *Amblystegium Vallis-clausae* Brid.

9. — **Batrachospermum moniliforme** *Roth* in Fl. Germ., IV, p. 450 (1800) ; *De Toni,* loc. cit., p. 50 ; *Pascher,* loc. cit., p. 301 ,

(1) Demaret, F., Muscinées récoltées dans le Jurassique les 19 et 20 juin 1937, in *Bull. Soc. Roy. Bot. Belg.*, LXX, p. 141 (1938).

Hamel, loc. cit., p. 301 ; *De Wild.,* Fl. Alg. Belg., p. 405 (1896) ; *De Wild.,* Prodr. Fl. Belg., p. 182 (1898-1907).

Icones : *Sirod.,* loc. cit., pl. 1-2-3-4-6-9 ; *Pascher,* loc. cit., p. 176, fig. 25-26.

Exsiccata : *Van Meel,* Algae Belgicae Exsiccatae, Dec. 1, N° 8 (1939).

Localités : Spa : Promenade de Meyerbeer, 1885, *De Wildeman* (Br.) ; Warnant, Molignée riv., 1938, *E. Hostie* (V. M.) ; Luxembourg, Limmerschmelz, 7 Fontaines, 1938, *Dr. Gregorius* (V. M.) ; Wijneghem, Grand Schijn, riv., 1938, *Van Meel* (V. M.) ; environs d'Anvers, *Westendorp* 350, 1851 (Br.) (V. M.).

Observation. — Station de Wijneghem. Le Grand Schijn longe le canal Albert pendant quelques centaines de mètres avant d'aboutir au siphon par lequel il est conduit sous le canal. La végétation y est très abondante et est constituée par les espèces suivantes : *Elodea canadensis, Glyceria fluitans, Callitriche verna, Ranunculus aquatilis.*

Nous y avons mesuré un pH = 8.0 ; l'eau était légèrement lactescente.

Composition de l'eau : O_2 = 12 mgr. °/₀₀ ; CO_2 libre = 4.4 mgr. °/₀₀ ; CO_2 combiné = 66 mgr. °/₀₀ ; Mat. Organ. = 38.4 mgr. d'Oxygène °/₀₀.

L'espèce est attachée aux pilotis en bois qui soutiennent le revêtement en pierre de la berge.

10. — **Batrachospermum radians** *Sirod.,* loc. cit., p. 218 ; *De Toni,* loc. cit., p. 52 ; *Hamel,* loc. cit., p. 304.

Synonyme : *Batrachospermum moniliforme* Van Meel in B. S. R. B. B., LXX, p. 91 (1937) (non Roth).

Icones : *Sirod.,* loc. cit., pl. 1-2.

Localités : Schooten, Peerdsbosch, 1936, *Van Meel* (V.M.) ; Hermeton, ruisseau, 1935, *E. Hostie* (V. M.) ; Onoz-Spy, étang du Château de Mielmont, 1938, *Van Meel* (V. M.) ; Philippeville, 1866, *A. Cogniaux* (Br.).

Observations. — 1. — Station au Peerdsbosch. Eau stagnante à pH = 7.5. Vegetation : *Riccia fluitans, Lemna trisulca, Hottonia palustris, Potamogeton alpinus, Elodea canadensis.* L'endroit est d'autant plus intéressant qu'il héberge : *Aphanothece stagnina,*

Draparnaldia glomerata, Cladophora glomerata, Vaucheria sessilis et *Fontinalis antipyretica.*

Le fond de cette formation est recouvert d'une masse considérable de feuilles mortes : *Alnus glutinosa, Salix aurita, Fagus silvatica, Castanea sativa, Quercus rubra.*

Le *Batrachospermum* se trouve immergé à une profondeur d'environ 25 cm., attaché aux pierres d'un barrage au milieu d'une végétation abondante de *Cladophora glomerata* et de *Vaucheria seccilis.* Eau très limpide de composition : O_2 = 11.2 mgr. °/₀₀ ; CO_2 libre = 4.4 mgr. °/₀₀ ; CO_2 combiné = 80 mgr. °/₀₀ ; Mat. Organ. = 24.8 mgr. d'Oxygène °/₀₀.

2. — *Etang de Mielmont.* — Formation stagnale assez étendue dans laquelle l'espèce est attachée aux pierres d'un petit barrage associée à *Chaetophora incrassata* (Huds.) Hazen.

Eau à pH = 7.5 ne contenant qu'un plancton pauvre caractérisé surtout par *Pediastrum muticum* Kg. var. *longicorne* Racib., *Pinnularia viridis* et quelques filaments de *Spirogyra setiformis.*

Les conditions dans lesquelles nous avons vu cette station ne nous ont pas permis de déterminer la composition de l'eau.

11. — **Batrachospermum densum** *Sirod.*, loc. cit., p. 228 ; *Hamel*, loc. cit., p. 305 ; *Pascher*, loc. cit., p. 179.

Icones : *Sirod.*, loc. cit., pl. 12-13-14 ; *Pascher*, loc. cit., pp. 178-179, fig. 30-31-32.

Localités : Malmédy, dans l'eau rouge, *M. A. Libert* (Br.) ; Schilde, Kleine Beek, ruiss., 1935, *Van Meel* (V. M.).

Observation. — Entrevue pour la première fois en 1935, il nous fut impossible de la retrouver en 1936, 1937 et 1938. Cette année, le 10-5-39, nous l'avons revue, mais à de très rares exemplaires. A cet endroit le lit du ruisseau est couvert de cailloux et la flore y est assez disséminée : *Glyceria fluitans, Elodea canadensis, Ranunculus aquatilis,* sur un fond sablonneux et très ferrugineux, vers les berges.

Eau à pH = 8.5. Composition : O_2 = 12.8 mgr. °/₀₀ ; CO_2 libre = 2.2 mgr. °/₀₀ ; CO_2 combiné = 66 mgr. °/₀₀ ; Mat. organ. = 37.6 mgr. d'Oxygène °/₀₀.

12. — **Batrachospermum pyramidale** *Sirod.*, loc. cit., p. 232 ; *De Toni*, loc. cit., p. 53 ; *Hamel*, loc. cit., p. 305 ; *Pascher*, loc. cit., p. 178.

Synonymes : *B. ectocarpum* Van Meel in B. S. R. B. B., LXX, p. 91 (1937) (non Roth) ;

B. sporulans Van Meel in B. S. R. B. B., LXX, p. 91 (1937) (non Sirod.).

Icones : *Sirod.*, loc. cit., pl. 15-16-17 ; *Pascher,* loc. cit., p. 177, fig. 27.

Exsiccata : *Van Meel,* Algae Belgicae Exsiccatae, Dec. 1, N° 2 (1939).

Localités : Tournai, *Marissal* (Br.) ; Tournai, *Lejeune* (Br.) ; Onoz-Spy, étang du Château de Mielmont, 1938, *Van Meel* (V. M.) ; 's Gravenwezel, 1936, *Van Meel* (V. M.) ; Luxembourg, Restaurant de la Gauhel près de la frontière du Grand-Duché, 1938, *Dr. Gregorius* (V. M.) ; Schilde, Kleine Beek, ruiss., 1935, *Van Meel* (V. M.) ; Hoogstraten, Marck riv., 1937, *Van Meel* (V. M.) ; Weert, fossé marécageux, 1936, *Van Meel* (V. M.).

Observations. 1. — L'espèce recueillie à Hoogstraten s'y trouve associée à *Chaetopora incrassata* (Huds.) Hazen dans une eau à pH = 7.5.

2. — A 's Gravenwezel l'espèce était particulièrement abondante en 1936. Formation à peu près stagnale à pH = 7.2. En 1937, la végétation semblait être en régression et en 1939 nous n'avons plus retrouvé aucun exemplaire.

3. — La station de Weert est le fossé caractéristique des terrains alluviaux situés le long de l'Escaut et longeant les cultures de *Salix viminalis* qui sert de base à l'industrie de l'endroit. La végétation y est très touffue : *Equisetum palustre, Iris pseudacorus, Phragmites communis, Lemna trisulca, Lemna minor, Juncus sp., Carex sp., Salix div. sp., Alnus glutinosa,* dans une eau à pH=7.7.

Composition de l'eau : O_2=11.2 mgr. °/₀₀ ; CO_2 libre=4.4 mgr. °/₀₀ ; CO_2 combiné = 110 mgr. °/₀₀ ; NaCl = 0.180 gr. °/₀₀, soit 0.3 gr. de Chlore par litre ; CaO = 140 mgr. °/₀₀.

La teneur en Chlore de cette eau la range parmi le type oligohalin (0.1 à 1.0 gr. °/₀₀).

Ici non plus, malgré les recherches les plus minutieuses et répétées très souvent, nous ne sommes plus parvenu à retrouver l'espèce. La végétation phanérogamique y est devenue tellement dense qu'elle intercepte trop de lumière nécessaire au développement de l'algue.

13. — **Batrachospermum arcuatum** *Kylin* in Nov. Act. Reg. Soc. Scient. Upsal., sér. IV, III, 3, p. 22 (1912) ; *Pascher,* loc. cit., p. 184.

Synonymes : *B. corbula* De Wild., Fl. Alg. Belg., p. 406 (1896) (non Sirod.).

Icones : *Pascher,* loc. cit., p. 182, fig. 40.

Exsiccata : *Van Meel,* Algae Belgicae Exsiccatae, Dec. 1, N° 9 (1939).

Localités : Presles, 1938, *Panneels* (V. M.) ; Ciply, 1854, *Tosquinet* (Br.) ; Rouge-Cloître, *A. Douret* (Br.) ; Schaerbeek, Vallée Josaphat, *A. Douret* (Br.) ; Auderghem : Trois Fontaines, 1885, *A. Douret* (Br.) ; Ruisseau de St-Hilaire, *Mansion* (Br.) ; Nivelles, 1890, *E. Marchal* (Br.) ; 's Gravenwezel, ruisseau au 's Gravenhof, 1937, *Van Meel* (V. M.) ; Nessonvaux, fontaines pures et tranquilles, 1821, *Lejeune* (Lg.) ; Renaix (Lg.).

Observations. — 1. La station indiquée par A. Douret : Trois Fontaines, a été revue par P. Heinemann, le 12 mars 1939 (V. M.).

2. — Ruisseau au 's Gravenhof à 's Gravenwezel. Le facies de cette belle station est assez désolant. Une riche végétation de *Ranunculus aquatilis* est arrêtée par un petit pont en briques contenant un barrage. Le lit du ruisseau en aval du barrage, à l'endroit où se trouve l'espèce est semé de briques, de débris de tuiles éparpillés sur un fond sablonneux. Quelques rares *Ranunculus aquatilis* restent encore.

En 1937, nous y avions observé un nombre de *Chaetophora incrassa* bien plus important et qui semble en régression.

Le pH, qui à cette époque était de 7.2, est monté à 7.7 et il est à prévoir qu'il doit subir des oscillations assez importantes par intervalles, car nous avons pu remarquer qu'actuellement un endroit situé en amont à quelques centaines de mètres de la station sert parfois de lavoir aux habitants d'une ferme située à proximité.

Composition de l'eau : O_2=13.6 mgr. °/₀₀ ; CO_2 libre=4.4 mgr. °/₀₀ ; CO_2 combiné = 66 mgr. °/₀₀ ; Mat. organ. = 67 mgr. d'Oxygène °/₀₀.

Note. — Récemment, en mai 1939, nous avons découvert un *Pseudochantransia Chalybea* (Roth) Brand dans un fossé au milieu des prairies s'étendant le long de la Krekelbeek (Vallée de la Nèthe entre Nijlen et Emblehem). L'espèce était attachée à une coquille de *Bythinia* sp.

Description de la station : *Riccia fluitans, Lemna minor, Lemna trisulca, Elodea canadensis, Myosotis palustris, Caltha palustris, Hottonia palustris, Alisma natans, Glyceria fluitans, Potamogeton crispus, Hypnum cuspidatum, Chara imperfecta, Vaucheria uncinata, Chaetophora* div. sp., *Tetraspora* div. sp.

Eau à pH = 6.5.

La recherche de *Batrachospermum* à cet endroit est demeurée infructueuse. Skuja, dans une note personnelle, explique la présence du *Pseudochantransia* de la manière suivante : « Man findet Sie hin und wieder auch auf Schalen von lebenden Molluscen in stehenden Gewässern ; die bewegungen der Schnecken vertreten in solchen Fällen die fehlenden Wasserbewegungen. Dass ein Batrachospermumstadium dabei nicht gefunden wurde, bedeutet nur, dass die äusseren Faktoren für die Entwicklung des Sexualreifen Sprosses ungunstig gewesen sind. »

Il faut probablement interpréter ce phénomène par le manque de lumière : « die Arten des Susswassers werden grössenteils als Jungendstadien und unter ungünstigen Beleuchtungsverhältnissen lebende Entwicklungsformen von Batrachospermum erkannt » (Pascher) (1).

Anvers, le 23 mai 1939.

(1) Pascher, *Susswasser-Flora Deutschlands, Oesterreich und der Schweiz*, XI, p. 166 (1925).

NOTE
SUR QUELQUES
ASCOMYCÈTES
NOUVEAUX
POUR LA FLORE BELGE

PAR

G. VERPLANCKE,

Dans cette note je donne quelques champignons qui ne figurent pas dans le Prodrome de la Flore Belge par É. De Wildeman et Th. Durand ou dont il y a lieu de rectifer la détermination. Le matériel examiné provient des herbiers du Jardin Botanique de l'État à Bruxelles.

SPHAERIALES.

Fam. **NIESSLIACEAE.**

LIZONIELLA *Sacc.* et *D. Sacc.*

Lizoniella Andromedae *(Rehm.) Kirschst.*, Ann. Mycol., XXXVII, p. 92 (1939).

Stigmatea Andromedae Rehm. in Sacc., Syll. fung., I, p. 542 (1882) ; Migula Krypt. Fl., X, 1, p. 268 (1913) ; De Wild. et Th. Dur., Prodrome, I, p. 273 (1898).

Habitat : Malmédy, à la face inférieure des feuilles d'*Andromeda polifolia*, Reliq. Libert., Sér. III, ined. 20.

Fam. **SPHAERELLACEAE.**

PLECTOSPHAERELLA *Kirschst.*

Plectosphaerella Himantia *(Pers.) Kirschst.*, Kryptog. Fl. d. Mark Brandenburg, VII, 3, p. 311 (1938) ; *Kirschst.*, Ann. Mycol., XXXVI, 5/6, p. 368 (1939).

Asterina Himantia (Pers.) Sacc., Syll. fung., I, p. 761 (1882).

Sphaeria Himantia Pers., Syn., p. 89 (1801).

Asteroma Himantia (Pers.) Fries, Summa Veg. Scand., II, p. 325 (1849).

Ascospora Himantia (Pers.) Rehm., Ascom., n. 131 (1896).

Habitat : Gomzé, tiges mortes d'Umbellifères, *Mouton.*

GUIGNARDIA *Viala* et *Ravaz.*

Kirschstein W., dans Kryptog. Fl. Mark Brandenb., VII, 3, p. 312 [1938] signale ce genre et en donne la description suivante :

« Fruchtkörper klein, meist herdenweise, anfangs immer eingesenkt, zuletzt manchmal fast oberflächlich, kuglich, linsenförmig oder napfförmig eingesunken, mit einer kleinen runden Mündung. Schläuche in Büscheln, von verschiedener Form, 8-sporig, ohne Paraphysen. Sporen fast immer einzellig, selten am unteren Ende mit einer undeutlichen Scheidewand, farblos.

Der frühere Name der Gattung *Laestadia* musste, weil ihn schon vorher eine Compositengattung erhalten hatte, zurückgezogen und durch den Namen *Guignardia* ersetzt werden (Intern. Regeln Bot. Nomenklatur, 3. Ausg. S. 121). »

En effet, nous trouvons dans de Candolle, Prodromus systematis naturalis regni vegetabilis, V, p. 374 (1836) ; CCVI, *Laestadia*, Kunth in Less., syn. Comp., p. 203 (1832) : Compositae-Asteroideae.

Seulement, F. C. Clements et C. L. Shear, dans leur ouvrage, The genera of Fungi, 1931, p. 260, signalent divers genres comme synonymes de *Phomatospora*, parmi lesquels nous trouvons *Guignardia* Viala et Ravaz et *Laestadia* Auersw. (non Kunth).

Voici d'ailleurs la description de ces champignons que nous trouvons dans Saccardo, Sylloge fungorum :

Laestadia Auersw. in Hedw. (1869), p. 177 reform. (Etym. a Doct. C. P. Laestadia, Sueco) (Sacc., Syll. fung., I, p. 420) :

« Perithecia lenticularia, innata, membranacea, typice poro simplici pertusa, subinde subastoma. Asci aparaphysati, octospori, saepius clavatuli. Sporidia ovoidea v. oblonga, continua, hyalina. Fungi minuti, saepius foliicola, *Sphaerellae* analogi, sed amerospori. »

Phomatospora Sacc., Fungi Ven., Ser. II, p. 306 (in Nuov. Giorn. Bot. Ital., VII [1875]) ; (Etym. a *Phoma* quia ejusdem sporidia spermatiis *Phomae* similia sunt) (Sacc., Syll. fung., I, p. 432).

« Perithecia membranacea, minuta, tecta v. erumpentia, discreta, ostiolo papillato. Asci cylindraceo-filiformes, aparaphysati. Sporidia octona, monosticha, phomatoidea, continua, hyalina, 2-guttulata includentes. Status spermogonicus *Phomam* referens ? »

En outre ,dans le même volume (Nuov. Giorn. Bot. ital., VII), nous trouvons, p. 363 :

« Conspectus synopticum generum :

b) perithecia immersa :

1. Asci aparaphysati :

(a) Perithecia globosa : asci longe cylindracei : *Phomatospora.*

(b) Perithecia typice depressa ; asci clavulati : *Guignardia.*

Saccardo, Syll. fung., XI, p. 289, donne les renseignements suivants :

« *Laestadia* Auersw., Syll. I, p. 421 ; IX, p. 577. — *Guignardia* Viala et Ravaz, Bull. soc. mycol., 1892, p. 63 ; *Carlia* Bonord., nec Rabenh. »

En note nous lisons : « Cl. doct. P. Magnus in Oesterr. Not. Zeitschr., 1894, n. 6, forte non immerite contendit, nomen *Carlia* Bonorden (1864) (nec Rabenh., 1857) pro *Lacstadia* Auersw. (1869) (nec Lessing, 1832) esse jure prioritatis adhibendum. Hic vero non expedit sine necessitate tot species novo nomine salutare. Nihil revera obstat ut jam monui, quod fungum *Laestadium,* phanerogamam autem *Laestadium* vocare pergamus. »

Nous lisons dans Saccardo, Syll. fung., XIV, p. 516 :

« *Laestadia* Auersw. », et en note : « Quod ad nomen *Laestadia* pertinet, cfr. Syll. fung., XI, p. 289 (nota). Rationibus datis etiam nomen *Guignardia* Viala et Ravaz (1892) superfluum evadit. »

Dans Saccardo, Syll. fung., XVI, p. 455 et XVII, p. 537, nous trouvons, au nom de *Laestadia*, la même note que dans le volume XIV.

La mention suivante est donnée dans les « Index universalis » du Saccardo, XVIII, p. 779: « *Guignardia* Viala et Ravaz, 1892 = *Laestadia* Auersw., Syll. fung., XI, p. 289 et XIV, p. 516. »

Or la situation se complique encore du fait que nous trouvons dans Saccardo, Syll. fung., XIX, les indications suivantes:

P. 799: *Guignardia* Viala et Ravaz. — Cfr. *Laestadia* et *Physalospora*; p. 1043: *Laestadia* Auersw. (*Sphaeriaceae*). — Cfr. etiam *Physalospora*.

Voici, d'autre part, la description que donne Saccardo, Syll. fung., I, p. 433, de ce champignon:

« *Physalospora* Niessl, Notiz. neue und krit. Pyr., p. 10 (Etym. *physis* vesica, quia sporidia vesiculosa). Perithecia globulosa, tecta, membranacea v. coriaceo membranacea, atra, ostiolo typice papillato erumpente. Asci paraphysati, tereti-clavati, crasse tunicati, octospori. Sporidia ovoidea v. oblonga continua, hyalina v. subhyalina [A gen. *Laestadia* paraphysibus, ostiolo etc., differt (ut *Didymella* a *Sphaerella*) sed plurimae species, adhuc imperfecta descriptae, ancipites manent, hinc in utroque genere quaerendae.] »

Clements et Shear (loc. cit.) donnent, dans leur clef des *Sphaeriaceae*, p. 62, les différences suivantes que nous relevons ici:

(2) Perithecia without clypeus or epistroma:

(a) Paraphyses present...

(o) Perithecia not in lichens: *Physalospora*.

(c) Paraphyses or paraphysoids lacking...

(n) Perithecia not lichenicole: *Phomatospora*. »

Ces auteurs établissent donc comme une des différences typiques entre les deux champignons, la présence ou l'absence des paraphyses. Ceci correspond à la description donnée ci-dessus du *Physalospora*. On comprend difficilement comment *Laestadia*, dont les asques sont « aparaphysati », puisse être un synonyme de *Physalospora*.

Remarquons en outre que dans Migula, Kryptogamen Flora von Deutschland, III, 1, p. 321, le genre *Physalospora* est rangé dans la famille des *Pleosporaceae*.

Signalons que Saccardo, Syll. fung., XIX, ne mentionne plus le genre *Guignardia*.

Enfin, Saccardo, Syll. fung., XXII, p. 72, reprend le genre « *Guignardia* Viala et Ravaz. — *Laestadia* Auersw. ». On y trouve en note : De nominibus *Laestadia* et *Guignardia*. Cfr. Traverso, Fl. ital. cryptog., Pyrén., p. 375.

Voici la teneur de cette note :

« A proposito della controversa de nominazione di questo genere osservo che, avendo constatato col prof. Saccardo che il genere di Fanerogame *Laestadia* Kunth in Lessing (1832) deve essere scritto col dittongo *ae* perchè dedicato al botanico svedese Laestadius, e non puo scriversi *Laestadia* come fecce il De Candolle, deve necessariamente cardere il genere di Funghi *Laestadia* Auersw. (1869) che è posteriore.

Nè si puo accettare il nome *Carlia* (o *Karlia*) creato dal Rabenhorst per un fungo (*Carlia Oxalidis*) che non è ascrivibile al genere del quale ci occupiamo ad erroneamente esteso dal Bonorden ad altre specie.

Reste pertanto valido e giustificato il nome *Guignardia* creato da Viala et Ravaz. »

Voici d'ailleurs la description donnée par Traverso de ce champignon :

« Genus LXXIV. — *Guignardia* Viala et Ravaz (1892) in Bull. Soc. Mycol. France, VIII, p. 63. — *Carlia* Bonord. in Abhandl. naturf. Gesell. Halle, VIII, p. 152 (1864) pr. p. nec Rabenh. — *Laestadia* Auersw. in Hedw., VIII, p. 177 (1869) ; Sacc., Syll. fung., I, p. 420 ; nec Kunth (1832) (Etym. a cl. botanico gallico L. Guignard).

Perithecia sparsa, immersa vel erumpentia, membranacea, lenticularia vel sphaeroides, typice non vel vix papillata, ostiolo minuto perforata vel etiam subastoma. Asci cylindracei vel clavati, aparaphysati, octospori. Sporidia ovoidea vel oblonga, continua, rarius prope basim spurie septata hyalina. — Status pycnidicus in nonnullis speciebus notus et *Phomam* referens.

Oss. Questo genere comprende funghi minuti, di solito follicoli, simili alle *Sphaerella* ma con spore continue. E un genere numeroso e che avrebbe bisogno di una revisione monografica. »

Nous trouvons également dans Saccardo, Syll. fung. XXII, dans les *Sphaeriacea,* p. 78, le genre *Phomatospora* Sacc. et p. 80, le genre *Physalospora* Niessl.

Enfin, Saccardo, Syll. fung., XXIV, mentionne dans le groupe des *Sphaeriaceae*, p. 778 : *Guignardia* Viala et Ravaz, Syn. : *Laestadia* Auersw., p. 794 : *Phomatospora* Sacc., et p. 795 : *Physalospora* Niessl.

Dans les flores allemandes, le genre *Guignardia* est actuellement classé parmi les *Sphaerellaceae*, alors que le genre *Phomatospora* se retrouve dans les *Gnomoniaceae*.

Migula, dans Kryptog. Fl. v. Deutschl., X, 1, p. 257, donne les caractères suivants des *Mycosphaerellaceae* (actuellement nommés *Sphaerellaceae*) :

« Fruchtkörper meist unter der Epidermis, seltner unter der Cuticula gebildet, bedeckt bleibend, höchstens durch Abheben der deckenden Schicht etwas vortretend, sonst nur mit der einfach durchbohrten oder etwas kegelförmigen Mündung hervorbrechend, kuglich, meist sehr klein. Gehäuse häutig oder lederig, meist sehr zart. Schläuche büschelförmig verbunden, meist achtsporig. Sporen verschieden gestaltet, meist nur durch Querwände, selten mauerförmig geteilt, farblos bis dunkelbraun. Paraphysen fehlen oder undeutlich... »

Il range dans cette famille le genre *Guignardia* Viala et Ravaz dont il donne la description suivante, p. 259 :

« Fruchtkörper eingesenkt, kuglich oder etwas flach. Gehäuse schwarz, häutig, kahl. Mündung flach oder schwach warzen- oder kegelförmig, seltener fehlend. Schläuche meist keulig, seltener länglich, achtsporig. Sporen ellipsoidisch oder spindelförmig, farblos, etwas gebogen, einzellig, häufig aber bei der Reife durch eine Querwand in zwei sehr ungleich grosse Zellen geteilt. Paraphysen fehlen. Saprophyten. »

Dans la même flore, nous trouvons la famille des *Gnomoniaceae* avec les caractères suivants, p. 459 :

« Fruchtkörper ohne Stroma, nur bei *Mamiania* findet sich eine Art Clypeus. Perithecien eingesenkt, unter sich frei, mit der langen, schnabelartig ausgezogenen, selten nur warzenförmigen Mündung hervorragend. Gehäuse häutig oder lederig. Schläuche meist am Scheitel mit Verdickung die von einem Kanal (Porus) durchzogen ist. Sporen farblos. Paraphysen meist fehlend. »

Il classe dans cette famille le genre *Phomatospora* et en donne la description suivante (p. 459) :

« Fruchtkörper ohne Stroma, eingesenkt, seltener später hervorbrechend, mit der warzenförmigen Mündung hervorragend, kuglich.

Gehäuse schwarz, häutig. Schläuche dünn, cylindrisch, achtsporig. Sporen einzellig, farblos, klein, einreihig, ellipsoidisch. Paraphysen meist fehlend. »

On peut aisément se rendre compte en comparant la description de ces deux genres que la différence n'est pas fortement marquée.

Kirschstein (Kryptog. Fl. d. Mark Brandenburg, l. c., p. 305) donne les caractères suivants des *Sphaerellaceae* :

« Die Fruchtkörper sind immer glatt und kahl, oft mehr oder weniger glänzend, meist kuglich, aber auch flach linsenförmig oder eingesunken, napfförmig. Die Mündung besteht in den meisten Fällen nur aus einem kaum bemerkbaren rundlichen Loch, doch finden sich auch kurze, konische Ostiola. »

A la page 306, nous pouvons lire : « Das Fehlen der Paraphysen und die unten büschlich miteinander verbundenen Schläuche sind typisch für die Familie der *Sphaerellaceae.* »

Les échantillons que nous avons examinés présentaient des ostioles très simples, et les asques étaient réunis en faisceaux qui se laissaient difficilement séparer. Comme ce sont là des caractères soi-disant typiques pour les *Sphaerellaceae,* nous pouvons adopter pour le présent le nom de *Guignardia* Viala et Ravaz.

Voici les espèces nouvelles pour la Belgique que nous avons trouvées :

Guignardia Buxi *(Fuck.) Lindau* in *Kirschst.,* Kryptog. Fl. d. Mark Brandenburg, VII, 3, p. 316 (1938).

Laestadia Buxi (Fuck.), Sacc., Syll. fung., IX, p. 584 (1882).
Sphaerella Buxi Fuck., Symb. myc., p. 100 (1869).
Sphaerella Buxi Desm., Ann. Sc. nat., ser. 3, XIX (1852).
Sphaeria Buxi Desm., Kickx, Fl. crypt., I, p. 346 (1835).
Carlia Buxi (Fuck.) O. Kuntze, Rev. gén. Pl., II, p. 846 (1891).

Habitat : Yvoir, feuilles de *Buxus sempervirens, Bommer* et *Rousseau.*

Guignardia caricicola *(Fuckel) Migula,* Kryptog. Fl., X, 1, p. 264 (1913).

Laestadia caricicola Sacc., Syll. fung., I, p. 430 (1882).
Sphaerella caricicola Fuck., Symb. myc., p. 101 (1869).

Carlia caricicola (Fuck.) O. Kuntze, Rev. gén. Pl., II, p. 846 (1891).

Habitat : Groenendael, sur *Carex* sp., *Bommer* et *Rousseau*.

Guignardia Carpinea *(Fries) Schröter* in *Migula*, Krypt. Fl., 1, p. 262 (1913) ; *Kirschst.*, l. c., p. 319.

Carlia Carpinea (Fries) O. Kuntze, Rev. gén. Pl., II, p. 846 (1891).

Laestadia Carpinea Sacc., fung. it., p. 543 (1879) ; id., Syll. fung., I, p. 426 (1882).

Sphaeria Carpinea Fries, Syst. myc., II, p. 523 (1822).

Sphaerella Carpinea Auersw., in Rabenh., Myc. Europ., V-VI, p. 2 (1901).

Ascospora Carpinea Fries, Summa Veg. Scand., II, p. 425 (1849).

Habitat : Courtrai, sur *Carpinus Betulus, Westendorp;* Groenendael, *Bommer* et *Rousseau*.

Guignardia microspora *(Auersw.) Lindau* in *Migula*, l. c., p. 263 (1891).

Carlia microspora (Auersw.) O. Kuntze, Rev. gén. Pl., II, p. 846 (1891).

Laestadia microspora Sacc., Syll. fung., I, p. 424 (1882).

Sphaerella microspora Auersw. in Rabenh., Myc. Europ., V-VI, p. 16 (1901).

Habitat : Malmédy, chaumes et feuilles de *Calamagrostis, Reliq. Libert.*, Sér. III, ined.

Guignardia Niesslii *(Kunze) Lindau* in *Migula*, l. c., p. 262 ; *Kirschst.*, l. c., p. 315.

Carlia Niesslii (Kunze) O. Kuntze, Rev. gén. Pl., II, p. 846 (1891).

Laestadia Niesslii Kunze, Fungi Sel. exsic., n. 241 et in Hedw., 1881, p. 51.

Habitat : Malmédy, feuilles de Peuplier, *Reliq. Libert.*, Sér. III, inéd.

Guignardia perpusilla *(Desm.) Verpl.* comb. nov.

Laestadia perpusilla (Desm.) Sacc., Syll. fung., I, p. 422 (1882).

Sphaeria perpusila Desm., XX, Not. 13, p. 80 (1846).

Habitat : Courtrai, sur Graminées, *Westendorp;* Luxembourg, sur *Festuca sylvatica, Crépin.*

Guignardia Pinastri *(DC.) Lindau* in *Migula,* l. c., p. 264.

Carlia Pinastri (DC.) O. Kuntze, Rev. gén. Pl., II, p. 846 (1891).
Laestadia Pinastri Sacc., Syll. fung., I, p. 426 (1882).
Sphaeria Pinastri DC., Fl. fr., VI, p. 133 (1815).
Sphaerella Pinastri Cooke, Handb., n° 2575 (1871).

Habitat : Groenendael, feuilles de Pin sylvestre, *Bommer* et *Rousseau.*

Guignardia punctoidea *(Cooke) Schröter* in *Migula,* l. c., p. 263 ; *Kirschst.,* l. c., p. 315.

Carlia punctoidea (Cooke) O. Kuntze, Rev. gén. Pl., II, p. 846 (1891).
Laestadia punctoidea Auersw. in Hedw., p. 178 (1869).
Sphaerella punctoidea Cooke in Journ. of Bot., 1866.

Habitat : Uccle, Groenendael, feuilles de chêne, *Bommer* et *Rousseau.*

SPHAERELLA *Ces.* et *De Not.*

Sphaerella allicina *(Fries) Auersw.,* in *Rabenh.,* Myc. Europ. Pyr., V-VI, p. 19, fig. 69 (1901) ; *Kirschst.,* l. c., p. 396 ; *Sacc.,* Syll. fung., I, p. 522 (1882).

Sphaeria allicina Fries, Syst. myc., II, p. 437 (1822).
Mycosphaerella allicina Lindau, Hiflsbuch, II, p. 7 (1912).

Habitat : Malmédy, feuilles d'*Allium porrum, Libert.*

Sphaerella aquilina *(Fries) Auersw.,* l.c., p. 20, fig. 83 ; *Kirschst.,* l. c., p. 337.

Sphaerella Pteridis Cooke, Journ. of Bot., IV, p. 250 (1866).
Sphaerella aquilina Fries, Syst. myc., II, p. 522 (1822).

Habitat : Dalembreux, *Pteris aquilina, Bommer* et *Rousseau.*

Sphaerella Asperifolii *Bomm.* et *Rouss.* in *Sacc.,* Ann. mycol., VI, p. 508 (1905) ; *Sacc.,* Syll. fung., XXII, p. 137 (1913).

Habitat : La Panne, feuilles mortes de *Cynoglossum* sp., *Bommer* et *Rousseau.*

Sphaerella effigurata (Schw.) Cooke, Journ. of Bot., 1883, p. 107.

Sphaeria effigurata Schw. in Sacc., Syll. fung., IX, p. 644 (1891).

Habitat : Bois de Vichenet, sur *Fraxinus excelsior, Verplancke.*

Sphaerella innumerella *Karst.,* Myc. Fenn., II, p. 182 (1876) ; *Sacc.,* Syll. fung., I, p. 506 (1882) ; *Kirschst.,* l. c., p. 387.

Habitat : Ebly, feuilles mortes de *Comarum palustris, Bommer* et *Rousseau.*

Sphaerella leptidea *(Fries) Fuck.,* Symb. mycol., p. 100 (1869) ; *Sacc.,* Syll. fung., I, p. 535 (1882).

Sphaeria leptidea Fries, Syst. myc., II, p. 522 (1822).

Habitat : Malmédy, feuilles tombées de *Vaccinium Vitis idaca, Libert.*

Sphaerella melanoplaca *(Desm.) Auersw.,* in *Rabenh.,* Myc. europ. Pyr., V-VI, p. 13, fig. 108 (1901) ; *Sacc.,* Syll. fung., I, p. 506 (1882).

Sphaeria melanoplaca Desm., XX, Not. 10, p. 80 (1846).

Habitat : Namur, sur feuilles de *Geum urbanum, Bellynck.*

Sphaerella Oedema *(Fr.) Fuck.,* Symb. myc., p. 104 (1869) ; *Niessl.,* Beitr., p. 17, t. II, fig. 14 (1872) ; *Sacc.,* Syll. fung., I, p. 490 (1882).

Sphaeria Oedema Fr. in Duby, Bot. Gall., II, p. 696 (1828).

Habitat : Gand, feuilles de l'*Ulmus campestris, Westendorp.*

Sphaerella Populi *Auersw.* var. **Fuckelii** *Sacc.,* Syll. fung., I, p. 488 (1882).

Sphaerella Populi Fuck., Symb. myc., App. II, p. 20 (1869).

Habitat : Malmédy, sur feuilles de *Populus nigra, Reliq. Libert.,* Sér. III, inéd.

Sphaerella rubella *Nicssl.* et *Schröt.,* Hedw., 1877, p. 118 ; *Sacc.,* Syll. fung., I, p. 518 (1882) ; *Kirschst.,* l. c., p. 377.

Habitat ; Beaufays, sur *Angelica sylvestris, Mouton.*

Sphaerella sarracenica *Sacc.* et *Roum.*, Reliq. myc. Libert., Sér. II, n° 136, t. XX, fig. 12 (1880) ; *Sacc.*, Syll. fung., I, p. 509 (1882).

Habitat : Malmédy, feuilles mortes de *Senecio sarracenica*, *Reliq. Libert.*, n° 1607 de C. Roum. F. gal. exs.

PHAEOSPHAERELLA *Karst.*

Phaeosphaerella macularis *(Fries) Kirschst.*, l. c., p. 420.

Sphaeria macularis Fries, Syst. myc., II, p. 502 (1822).

Pirostoma macularis Fries, Summa veg. Scand., p. 395 (1849).

Sphaerella macularis Karsten, Symb. Myc. Fenn., II, p. 174 (1876).

Mycosphaerella macularis Schroet., Pilze Schlesiens, 2 Hälfte, p. 335 (1908).

Sphaerella maculosa Sacc., Syll. fung., I, p. 487 (1882).

Phaeosphaerella maculosa Karst., Symb. Myc. Fenn., XXVI, p. 28.

Habitat : Gand, feuilles de *Populus tremula*, *Verplancke*.

Phaeosphaerella sentina *(Fries) Verpl.* comb. nov.

Sphaerella sentina (Fries) Sacc. (nec. Fuck.), Syll. fung., I, p. 482 (1882).

Sphaeria sentina Fries, Syst. myc., II, p. 520 (1822).

Habitat : Watermael, feuilles de *Pirus communis*, *Bommer* et *Rousseau*.

SACCOTHECIUM *Fries.*

Saccothecium sepincolum *Fries*, Summa Veg. Scand., p. 398 (1849) ; *Kirschst.*, l. c., p. 425.

Sphaeria saepincola Fries, Syst. myc., II, p. 498 (1822).

Sphaeria intermixta Berk. et Br., Not. of Brit. Fungi, n° 639 (1860).

Sphaerella intermixta Auersw., Oesterr. Bot. Zeitschr., 1868, p. 278.

Stigmatea seriata Winter, Flora, 1872, p. 544.

Sphaeria glomerulata Fuckel, Symbol. myc., p. 113 (1869).

Sphaerulina intermixta Sacc., Syll. fung., II, p. 187 (1883).

Metasphaeria sepincola Sacc., Syll. fung., II, p. 164 (1883).
Didymella glomerulata Sacc., Syll. fung., I, p. 546 (1882)

Habitat : Yvoir, rameaux de *Betula alba, Bommer* et *Rousseau.*

PHAEOSPHAERULINA *Pass.*

Phaeosphaerulina constricta *(Starb.) Sacc.,* Syll. fung., XI, p. 350 (1895).

Sphaerulina intermixta (Berk. et Br.) Sacc. var. *constricta* Starb., Ascom. Oeland, p. 15, f. 5 (1890) ; Sacc., Syll. fung., IX, p. 848 (1891).

Habitat : Marche-les-Dames, sur Rosiers, *Bommer* et *Rousseau.*

Université de Gand, Laboratoire de systématique,
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